Web Technology support for more effective Higher Education: A Formative Evaluation

A thesis

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by

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Abstract

Do WWW based technologies provide a pedagogically sound foundation on which to build more effective higher educational systems? This study describes research conducted with a large (600+ students) first year accounting course during March-April 1998. The research focused on the impact of a web learning environment on student learning. The research used multiple methods to gain insight into the learning phenomenon including: case study, experimental and survey work. The research design generated both quantitative and qualitative data with which to test a research model and a series of hypotheses. Major findings included a supporting chain of evidence that the web learning environment had a significant positive impact on student learning working through the intervening variable of student attitude towards the subject content area. The positive impact on student learning was significant for both deep and surface learning, using Bloom's taxonomy for measuring depth of learning. Students also appeared to learn more with less time-on-task. Student participants were largely enthusiastic about the system. However a significant minority preferred more human contact than was provided. Outcomes of the study included formative recommendations for future research and development of web based courses including collaborative and quality recommendations.

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Dedication

The hard work and frustrations involved in working on a larger piece of research is well known to researchers the world over. One of the most difficult aspects and therefore most important is the time spent on the keyboard, the crucial writing up stage. Bringing the work to completion and committing it to paper is the final task, the completion of which, like the horizon, recedes as you approach it. The unending drafts, re-writes and corrections, those times when you are in desperate need of inspiration in the middle of a concept that is not quite coming together. In those frustrating and confusing times I found the inspiration that I needed, not on the keyboard, but on my knees. So I wish to dedicate this work to "...my heart and my soul's inspiration...", the Lord Jesus Christ. Thank you Lord for your patient care and unending help.

Chapter 1: Introduction

This author together with a number of international colleagues presented a plenary session on the development of a Web based, multi-media, multi-national, interactive case [HREF1] to the World Association for Case Research and Application (WACRA) at their international conference in Warsaw Poland in June 1996. The presentation was enthusiastically received, however one question was raised which left the author disturbed. That question was "what is the evidence that this method of instructional delivery (referring to Web based technology) is any more effective than traditional classroom teaching?" This experience was the genesis of the following thesis which addresses the question: "Do World Wide Web (WWW or Web) technologies provide a pedagogically sound foundation on which to build more effective higher education systems?"

Background

The transition from a production and service based international economy to an information based economy raises a wide range of issues. Foremost among these is how populations will be educated to meet the information and knowledge intensive demands of such an economy? How will a society afford these educational demands?

The greatest natural resource any organisation or country has is the intellectual capacity of its people. This capacity is often not developed to the maximum due to the way the traditional classroom functions with only a small proportion really mastering the material. Benjamin Bloom and his graduate students found that students learning in a one-on-one tutoring environment performed two standard deviations (sigma) better than students in classroom settings (30 students with one teacher). This means that the average student learning in a one-on-one environment performs as well as the top 5% of students in the traditional classroom (Bloom, 1984; Woolf, 1992). This is referred to as the two-sigma effect. Of course one-on-one tutoring is prohibitively expensive, so Bloom's challenge to educators is to find other equally effective systems, that are more affordable than one-on-one tutoring. The impact of such performance enhancement on individual confidence, creativity and value to the community and economy would be enormous.

The rise of the Internet to prominence on the technology horizon during the 1990s has offered a possible way forward on these issues. But the Internet answer raises many more questions. Questions about its effectiveness as an educational medium, and the influence that it might have on the future of higher education. There is currently much work being done to experiment with the use of this technology in delivering educational programmes (Aoun 1996, Bearman 1996, Bytheway 1996, Eden et al 1996, Galegher and Kraut 1994). However very little work has been done to date on the effectiveness of this media (Harris, 1998; Borras, 1998).

With the explosive growth of the Internet and related application of the World Wide Web (WWW) there is much discussion on the application of this technology to electronic commerce and the information society. One of the largest information based segments of our economy is the education sector. Primary, secondary and tertiary education together with corporate training and continuing education represent one of the largest and most knowledge intensive areas for application of this new technology. But does Web based technology really provide a pedagogically sound foundation on which to build more effective (as well as efficient) educational programmes? Or is it just another "flavour" of the year (or decade) technology that will in the end have very little impact on long term educational issues?

The application of Internet based technologies to tertiary education may be viewed in its context by comparing the traditional Residential University setting to the Distance Learning University. This comparison is shown in Figure 1-1, with the Virtual University shown as a synthesis of these two traditions (Hutchison, 1995a).

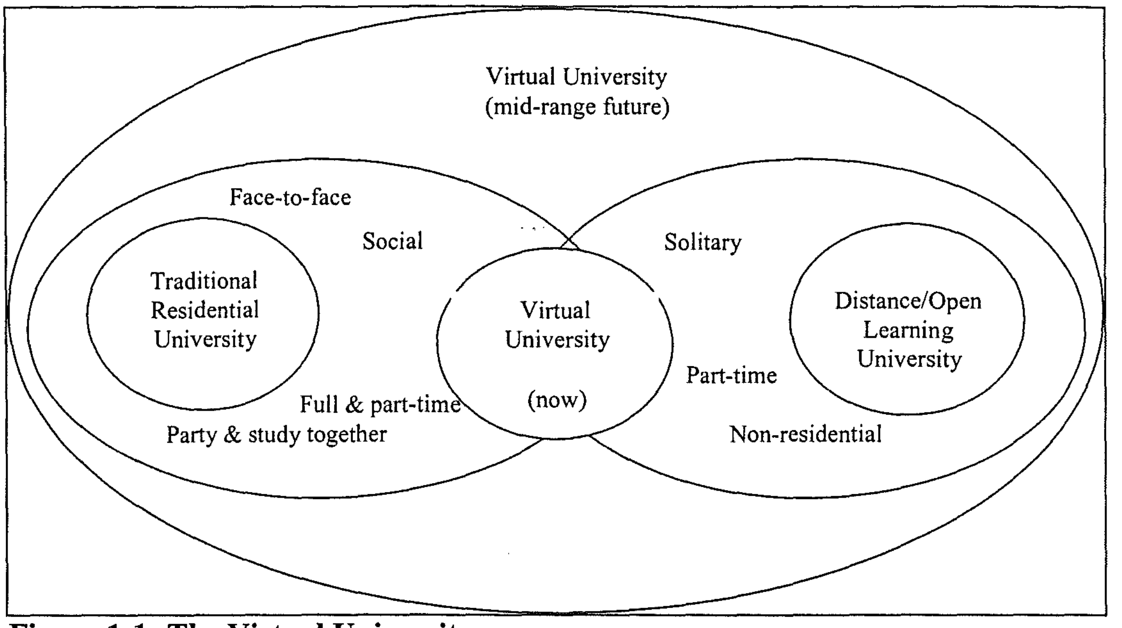

Figure 1-1: The Virtual University
(based on Hutchison, 1995a)

The traditional residential University offers a social setting for largely full time learning. Face-to-face encounters with teachers and other students are an important part of this learning system. The setting for the typical distance learning system is quite different however. It is usually occupied by isolated part time learners who have to make it mostly on their own. The Virtual University currently occupies a space overlapping these two institutional structures. Some prognosticators suggest that the Virtual University will supplant both of these traditional forms of education using high technology to accomplish what social settings have not been able to.

Questions about the effectiveness of the Virtual learning settings, and particularly the efficacy of Web technologies, and their support for effective learning methods is the focus of this study. The remainder of this chapter broadly describes the strategy used in carrying out this research as well as an outline of the thesis chapters.

Research strategy

Given the lack of in-depth research on the effectiveness of Web based learning environments, this study was formative in nature. The primary objective of the study was to determine if a web based learning environment could support more effective learning and the reasons why. The study used multiple analysis methods to gain an in-depth understanding of the learning processes including the issue of depth of learning, using Bloom's Taxonomy. The study was conducted in conjunction with a first year University Accounting course in which treatment group students used a Web based system for tutorials, thus there was a primary unit of analysis (the whole class) and embedded units of analysis (individual students, individual tutorials groups and groups of tutorials: treatment and control). Figure 1-2 provides an outline of the research strategy used. The strategy involved three data collection and analysis approaches based on a theoretical foundation drawn from the Educational Technology and Information Technology Literatures. These methods included:

1. A case study approach incorporating a range of qualitative methods to gain an in-depth understanding of the learning processes. The methods included: observations, interviews, focus group meetings, e-mail comments and follow-up interviews. These were carried out with a sample of tutorials and students involved in the treatment group.

2. An experimental study to assist in creating a supporting chain of evidence. The experimental portion of the study used tutorial groups randomly assigned to treatment and control groups. The design included a pre-test and post-test covering course content knowledge divided along the High and Low portions of Bloom's Taxonomy. An attitude survey was also included with the pre-test and post-test to determine the change in attitude towards the course content and toward the computing environment during the experimental period.

3. A learning survey to determine student views on the effectiveness of their learning environment was conducted with both the treatment and control groups.

The approach to carrying out the research incorporated the following steps:

1. A review of the literature was carried out including modern pedagogy, educational technology and Information Technology Literatures. From this foundation of theory a research model was developed.

2. A research design, informed by the literature, was developed. This design was created to test the research model and related hypotheses, gain an in-depth understanding of the learning processes under study and provide formative information for future studies.

3. Implementation of the three major data collection approaches: experimental, survey and qualitative.

4. The data was collected, recorded, cleaned and descriptive statistics computed.

5. The data was analysed in the light of the study hypotheses. First separately for each of the three major methods: experimental, survey and qualitative. The results from the three methods were then synthesised to determine the extent to which each did or did not support the study hypotheses.

6. An interpretation of the results of the analysis was carried out, including considering the implications of the findings for theory and for practice, as well as consideration of rival interpretations of the findings.

7. The findings of the study were summarised and conclusions drawn, including suggestions for future research and formative recommendations for development of Web enabled courses.

Thesis structure

An outline of the thesis chapters is given below and is reflected in Figure 1-2.

Chapter 1	Provides an overview of the research study, including the background, strategy and structure of the research.
Chapter 2	Presents a review of the relevant literatures in modern pedagogy, education technology and Information Technology. This chapter also provides the theoretical foundations for the study.
Chapter 3	Describes the research questions, hypotheses, model and processes that act as the blueprint for this study.
Chapter 4	Presents the objectives, processes and results from the experimental portion of the study including the outcomes

regarding the study hypotheses.

Chapter 5	Presents the objectives, processes and results from the survey portion of the study including the outcomes regarding the study hypotheses, most valuable features of the web enabled environment, and formative recommendations .
Chapter 6	Presents the objectives, processes and results from the qualitative portion of the study including the outcomes regarding the study hypotheses and formative recommendations.
Chapter 7	Provides a synthesis of the study results from Chapters 4, 5 and 6, demonstrating the level of combined support for the research hypotheses and describing the formative recommendations.
Chapter 8	Provides a discussion of the study findings in the light of the literature together with the significance of the findings and their implications for theory, practice and future research. Also included are rival interpretations of the findings and limitations of the study. The chapter concludes with a brief summary of the study.
Appendices	Contains supporting materials for the study including: details of the case study protocol, copies of learning surveys and interview questions, focus group information, detailed student comments, pre-test and detailed regression tables for the impact analysis.

Related works that have been published or presented

A number of papers have been written by the researcher on this topic area and are listed below for reference:

Refereed conference proceedings

Vargo, J.J., and Cragg, P.B., "Use of WWW Technologies in IS Education", in Proceedings of the 10th Australasian Conference on Information Systems , Wellington New Zealand, December 1999.

Vargo, J.J., "WWW Technologies and Tertiary Education: Panacea or Placebo?", in Proceedings of the Association of Tertiary Managers in New Zealand annual conference, Christchurch New Zealand, July 1998.

Vargo, J.J, "Evaluating the Effectiveness of Internet Delivered Coursework", in Proceedings of the AusWeb97 Conference, July 6-9, 1997, Australia.

Vargo, J.J., Hawthorne, L., Mironski, J., Schroeder, A., Osterczuk, A., "The Harlequin Company: A Multi-media, Internet Delivered Case Study" in Proceedings of the 13th International Conference of the World Association for Case Research and Application, June 1996.

Unrefereed conference proceedings and presentations

Vargo, J.J., "Deeper Learning and WWW Technologies: paradox or prevarication". Paper, presented at the On-line Teaching and Learning-1999 Conference, Pittsburgh USA, March 1999

Vargo, J.J., "Delivering Accounting Education with WWW Technologies: A Formative Evaluation", presented at the Accounting Association of Australia and New Zealand annual conference, July 1998.

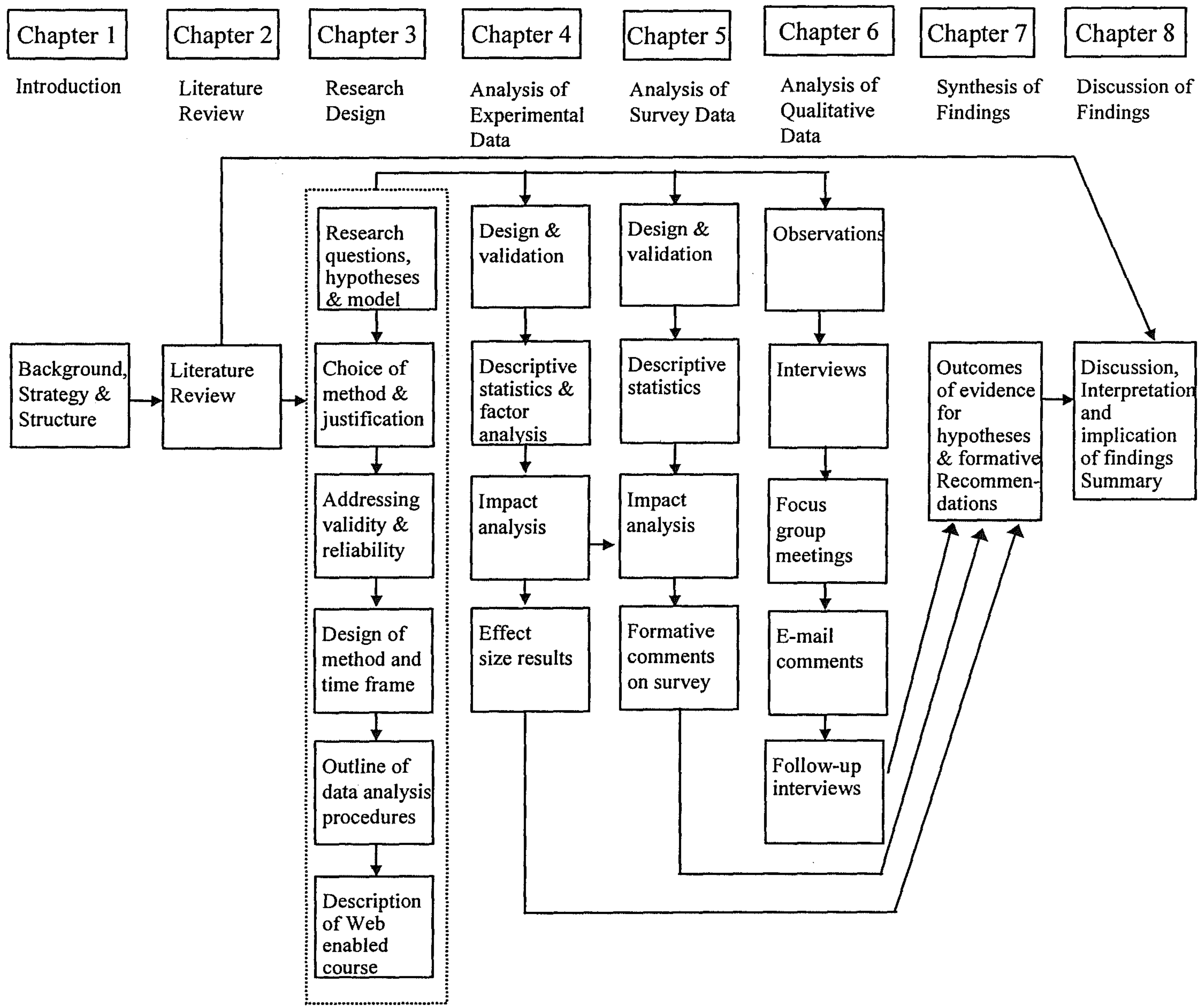

Figure 1-2: Map of thesis chapters and contents

Chapter 2: Literature Review

Introduction

The history of education can readily be seen as a history of the sometimes unsettled marriage of new technologies and new teaching methods beginning with primitive man. The methods were largely oral supported by the occasional high technology drawing, using charcoal on stone or bark tablets. In due course the methods changed, as did the technology for supporting education. Written language was developed, scrolls written and the new teaching methods developed. Chief among them the methods of Socrates. Unfortunately being innovative has not always been highly prized and was a prime reason for the forced suicide by hemlock of this father of modern education (Harcourt, 1963). The next major technology to impact education was the development of movable type by Gutenberg et al in the 1500s. This new technology, still wedded to the Socratic method by the enlightened, and the rote method by most, revolutionised not only education, but society. Part of the revolution was the revolution of senses. Prior to Gutenberg, words were spoken, after Gutenberg they were read. Prior to Gutenberg the speaker controlled, after Gutenberg the reader could control. This shift from the ear to the eye as the focus of education had a profound impact on the society of the day (McLuhan, 1962). As McLuhan expressed it:

> *"When technology extends one of our senses, a new translation of culture occurs as swiftly as the new technology is interiorized."*

The introduction of the radio and then television as media forms redressed the balance, but as an educational medium, produced a one way flow of information, leaving very limited room for discourse between teacher and student.

With the invention of the computer during World War II and its peace time development in the 1950s the debate continued over new media and instructional methods. In an article on computer-based College teaching, Kulik et al (1980) said:

"..farsighted educators...envisioned college classrooms in which computers would serve as infinitely patient tutors...not everyone shared the vision of a benign computer revolution however..."

The debate over what makes for effective teaching and learning, and what impact the chosen medium of delivery may have on the learning process thus continues. Now 40 years into the computer revolution, electronic technology has spawned the Internet and multimedia software capable of integrating text and graphics, video and audio, interaction and two way communication. Will this represent the next major evolutionary step in education, a major revolution, or be a non-event in the history of educational development?

This chapter reviews the Higher Education and Educational Technology literatures, focusing on the conjunction of effective pedagogy and the place of technology in effective learning. The primary themes that come through deal with:

- Effective learning: its models and methods
- The debate on effective learning causes via: media, methods and systems
- Distance learning versus flexible learning
- Impact of technology on higher education practice
- The Internet and higher education

This literature survey is organised in accord with the above themes presenting both affirmative and contrary view points on these themes. These themes are then synthesised and the chapter concludes with a section drawing together the threads of the literature that provide the foundation for the following chapters covering the research design and implementation portions of this study.

Effective learning

Definition of effective learning

The topic of effective learning is one that is naturally core to the whole process of higher education. Various definitions of effective learning have been posited including:

> "...learning in educational institutions should be about changing the ways in which learners understand, or experience, or conceptualise the world around them...learning as a qualitative change in a person's view of reality..." (Ramsden, 1992, p.4)
>
> "Education with inert ideas is not only useless, it is harmful...We enunciate two educational commandments, "Do not teach too many subjects," and again, "What you teach, teach thoroughly...Education is the acquisition of the art of the utilisation of knowledge..."(Whitehead, 1929 pp.2-6)
>
> In discussing deep versus surface learning, Marton (in Ramsden, 1992, pp.43-54) concludes that "It was overwhelmingly clear as well, however, that outcome and process were empirically linked", those who used deep learning processes passed the courses far more frequently than those using surface learning processes."
>
> "The cognitive domain... includes those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills... the affective domain...includes objectives which describe changes in interest, attitudes and values and the development of appreciations and adequate adjustment." (Bloom, B.S., ed. 1956, p.7)
>
> "Effective teaching is best estimated in relation to your own goals of teaching...is sometimes equated with successful teaching - that is, the students learn what is intended. While this argument has some appeal, it is not the whole of the matter. Effective teaching is concerned not only with success but also with appropriate values." (Brown & Atkins, 1988, p.4-5)
>
> "...true education for all is a major part of the answer. But we're not talking here about academic education. We're talking about personal growth (which includes self-esteem), life-skills and learning-to-learn. Once you know how to learn, you can accelerate learning." (Dryden & Vos, 1993, pp.19-21)
>
> "one six year old boy in the so-called LEGO/Logo class built a clump of blocks and placed a motor on top... wrote a more sophisticated program...result was a moving pile of blocks that followed a black squiggly line...child became a hero...This small moment of glory gave him something very important: the joy of learning. We may be a society with far fewer learning-

disabled children and far more teaching-disabled environments than currently perceived. The computer changes this by making us more able to reach children with different learning and cognitive styles." (Negroponte, 1995, pp.197-8)

So effective learning is not just about the efficient transfer of certain quantities of knowledge, but it is also about developing skills and attitudes for life-long-learning (Bowden & Marton, 1998). Effective learning is about experiencing the joy of learning, it is about both factual knowledge and developing good judgement. A summary of these differing characteristics of effective learning is seen in Figure 2.1.

Change the ways in which learners understand or view the world
Learning deeply so as to utilise that knowledge
Learning deeply depends on the learning process used
Recognition of knowledge and the development of intellectual abilities
Changes in interests, attitudes and values
Meeting the goals of the instructor and the instructional program
Personal growth and life skills
Life long learning skills, learning to learn
The joy of learning
Educational development for a range of different learning and cognitive styles

Figure 2-1: Characteristics of effective learning

Models of effective learning: Bloom's Taxonomy

The span of effective learning may be viewed as seen in two models: Bloom's and Marton's. The first is a taxonomy of educational objectives in the cognitive domain seen in Figure 2-2 based on Bloom's work. This model shows a hierarchy moving from the basic learning of information and facts (knowledge) through to the ability to evaluate and make judgements. Each level builds on prior levels of increasingly deep understanding and insight describing the depth and applicability of knowledge (Bloom, 1954): This taxonomy has been widely used for design and evaluation in the field of educational technology.

Evaluation: Judgements about the value of material and methods for given purposes. Qualitative and quantitative judgements about the extent to which material and methods satisfy criteria.
Synthesis: The putting together of elements to form a whole, arranging and combining so as to create a pattern or structure not evident before
Analysis: decomposition into constituent elements so that the hierarchy of ideas is made clear and the relations between ideas is made explicit.
Application: the use of abstractions to apply knowledge to other areas or fields and predict probable outcomes of introduced changes.
Comprehension: The lowest level of understanding with a basic ability to use the facts and information.
Knowledge: learning and recall of facts and information

Figure 2-2: Bloom's taxonomy of educational objectives in the cognitive domain

"Bloom's Taxonomy is a widely accepted and researched framework for evaluating cognitive abilities" (Jones and Paolucci, 1999) with the six levels of educational objectives (as seen in Figure 2-2) often classified into lower order (knowledge, comprehension and application) and higher order (analysis, synthesis and evaluation). Bloom's Taxonomy has been used productively to measure the effectiveness of educational technology on learning (both formative and summative) in a wide range of settings (Paolucci, 1998; Cox and Clark, 1998; Imrie, 1995; Brightman, 1984; Usova, 1997; Yunker, 1999; Sponder and Hilgenfeld, 1994; Mehta and Schlecht, 1998).

One of the ways in which Bloom's taxonomy can be used is in evaluation of learning outcomes. Setting learning objectives in line with Bloom's Taxonomy and then measuring student performance using these six levels can provide a sound understanding of the depth of students' learning (Bloom et al, 1971; Myers, 1999; Evans, 1998; Cassarino, 1998; Zakrzewski and Steven, 2000).

Cox and Clark used the taxonomy to assess student's knowledge in a computer programming course using the RECAP model (Cox and Clark, 1998; Imrie, 1995). This model is based on Bloom's Taxonomy, dividing the taxonomy into two tiers, a lower tier incorporating REcall, Comprehension and Application; and an upper tier called Problem solving, incorporating the upper three levels of Bloom's taxonomy. Researchers have split Bloom's taxonomy in various other ways. Harrell (2000) uses Bloom's taxonomy to consider approaches to language learning that will promote constructivist forms of learning and experimentation with language that will move the learner from lower order thinking (noted as the first two levels of Bloom's: knowledge and comprehension) to higher order thinking (noted as the top four level's of Bloom's: application, analysis, synthesis and evaluation).

Some researchers have used Bloom's taxonomy to design instructional units, using only part of the taxonomy, based on the needs of the course or content being learned. Cook and Kazlauskas (1993) describe a large scale Computer Based Training (CBT) curriculum as part of a technical training programme which applied the first three levels of Bloom's taxonomy to the curriculum design.

Although most researchers have found Bloom's taxonomy to be a valuable model in understanding depth of student learning, this has not been universal. Gierl (1997) found that Bloom's taxonomy did "not provide an accurate model for guiding [test] item writers to anticipate the cognitive processes used by students". His study however only covered the bottom portion of Bloom's taxonomy (knowledge, comprehension and application).

One of the crucial questions for effective learning in higher education is what process can best move a student's learning from the initial stages of learning the facts through the progression of understanding and application to the ability to synthesise and effectively evaluate? The next model addresses this question.

Models of effective learning: Marton

The second model based on Marton's work (Figure 2-3) is concerned with the approach to learning. Is the learning in context, retaining the structure of knowledge, or is it focusing on the facts and parts separate from the whole? What is learned, is it a deep understanding of the purpose and intention of the learning situation apprehended, or is attention simply given to the surface facts and symbols of the knowledge to be learned?

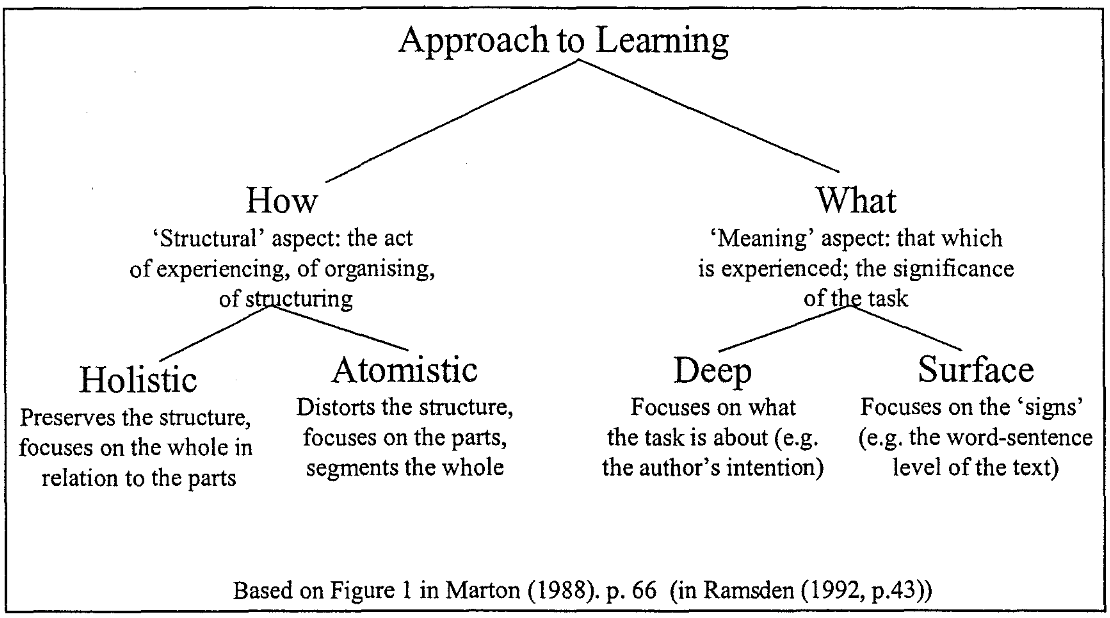

Figure 2-3: A model of learning approaches

A scale suggested by Entwistle and Brennan especially in the context of student essay's (1971) is similar, incorporating four levels of learning: deep active, deep passive, surface active and surface passive. (Imrie, 1995)

There is a range of learning processes and concepts that add to deep learning. Biggs (1987) points out that motive and strategy are important factors in learning with students tending to use three fundamental strategies he summarises as surface, deep and achieving (competitively motivated, aiming for the high grade rather than a particular type of learning).

The concept of situated learning is often associated with deep learning. Situated learning or in-context learning (Laurillard, 1993; Ramsden, 1992; Entwistle, 1983) involves placing the material to be learned into its real world context as much as possible thereby avoiding the atomistic approach and encouraging the holistic as seen in Figure 2-3. This may involve various processes such as using contextual problem solving and looking at the learning setting in creative and situated ways (Michalko, 1991). Situated learning is considered important in creating meaningful linkages between content, skill and student experience. (Choi and Hannafin, 1995)

Deep learning may also be facilitated by the design of the course work. Laurillard (1993) believes four key elements to such design are (1) structuring the knowledge, (2) providing for interactivity in the learning process, (3) providing formative feedback and (4) providing opportunities for the student to reflect on the outcomes of learning and thus modify mental models, erroneous concepts and unproductive attitudes. The concept of providing formative feedback is strongly supported by the work of Angelo and Cross (1993). Formative assessment involves testing students' knowledge and providing feedback to the student on how they are learning, during the learning process, rather than simply as summative assessment that gives them a grade at the end of the process.

Many of the concepts aimed at producing deeper learning fall under the alternative heading of learner centred education incorporating the constructivist view of the learning process (Norman and Spohrer, 1996; Hammersley, 1986; O'Connor, 1996). Learner centred education has a focus on engaging the student deeply in the learning process incorporating such concepts as problem based learning and complex problem solving (Guzdial, 1996). This approach to learning requires a change in role behaviour on the part of the teacher from the traditional "sage on the stage" role to one of the "guide on the side". Further developments of this guide on the side role can be seen in learning systems that incorporate the concept of scaffolded problem solving (Rosson and Carroll, 1996; Jackson, 1996). Scaffolding is the concept of providing support to "enable the learner to start doing the [authentic] task with his or her current [insufficient] understanding" (Soloway & Prior, 1996). This concept of scaffolding has typically been provided by the teacher, however educational technologists are now designing computer based learning systems to provide similar support.

Other models of effective learning: Biggs and Gagne

Two additional models found in the literature are Biggs SOLO model and Gagne's Learning capabilities model.

Biggs' SOLO model (Structure of Observed Learning Outcomes) is a five level model incorporating the deep and surface learning paradigm. The model levels include (1) prestructural: facts based, unable to generalise; (2) unistructural: able to generalise only in terms of one aspect; (3) Multistructural: able to generalise in terms of only a few limited and independent aspects; (4) Relational: induction, able to generalise within context of experience using related aspects; (5) Extended abstract: induction and deduction, able to generalise to situations not experienced. (Biggs & Collis, 1982; Ramsden 1992; McAlpine, 1996). This model is a hierarchy, in some ways related to Bloom's taxonomy, but is a more complex model associating learner age, levels of knowledge and learning cycles that are experiential in nature.

Gagne's learning capabilities model incorporate five classes of learned human capabilities that are not structured along a deep to surface continuum, unlike the previous models described. These five classes include: (1) verbal information; (2) intellectual skills; (3) cognitive strategies; (4) attitudes and (5) motor skills. The second class: intellectual skills is most related to the earlier models described, incorporating a hierarchy of skills, each one dependent on the earlier ones to enable the later. The levels of intellectual skills include: (1) lower order learning (stimulus-response and verbal associations); (2) discriminations (round from square, red from blue etc.); (3) concepts (classification of objects, properties and events); (4) rules (operations for dealing with objects, numbers, words and abstract concepts) and (5) problem solving.

These four models cover the broad spectrum of effective learning. Bloom's taxonomy is primarily concerned with the content aspects of effective learning, while Marton's model is concerned with the process aspects of effective learning. Biggs' is more developmental and experiential, while Gagne's covers the broad spectrum of cognitive, affective and motor skills.

There are however other issues of importance in the area of effective learning including learning style differences, collaborative learning processes and discovering systems to achieve Bloom's 2-sigma effect.

A crucial issue is the recognition that different students have a different mix of learning styles and backgrounds (Jensen, 1996; Dryden & Vos, 1993). This area covers such concepts as learning style in the context of visual, auditory and kinesthetic learners where a particular student may have a natural inclination to learn better while hearing and doing (auditory plus kinesthetic) while others may learn better when combining visual and auditory input. It also includes concepts covered by left brain-right brain theory and male –female learning differences which have much to do with the level of hormonal balance in individual students predisposing them to learn some types of material more readily (math versus history for example).

Collaborative learning processes involve the concept that students can support each other in the learning process. The combination of social context, motivational aspect and sharing of knowledge between students can be a powerful means for effective learning. (Alavi & Yoo, 1997; Alavi, 1997; Lim et.al., 1997; Laurillard, 1993) Tied to this concept of collaborative learning is the development of the Learning Organisation, wherein effective learning processes are incorporated into the corporate culture in order to maximise the creation and retention of knowledge useful to the organisation (Nevis et.al., 1995; Jensen, 1996).

The 2-sigma effect (Bloom, 1984; Woolf, 1992) is the impact that one-on-one tutoring has on student performance. A number of Bloom's graduate students' research demonstrated that students instructed in one-to-one tutoring settings performed two standard deviations (sigma) better than students in classroom settings (30 students with one teacher). In other words the average tutored student performed better than 95% of the classroom students. Unfortunately one-on-one tutoring is a prohibitively expensive way to deliver education. The challenge Bloom posits is finding cost effective ways of achieving the 2-sigma effect.

The next section introduces the "media versus methods" debate involving educational technology and learning methods and how effective learning is caused.

Effective learning: media, methods or systems?

Introduction

An ongoing theme in the Educational Technology literature has been the debate over what impact the delivery medium for an educational programme has on the learning outcomes for that programme, versus what impact the educational methods have on those learning outcomes. This debate is an important one in shedding light on the programme of research covered by this study. Internet technologies are a medium for delivering an educational programme. This section of the literature survey looks at this debate.

A review of the literature in this arena demonstrates that the debate crosses disciplinary boundaries from science and math to business and English with research results demonstrating improvements as a result of technology based systems. However at the same time the detractors claim confounding of results because of poor research designs. (Clark, 1983; Krendl & Lieberman, 1988; Kulik & Kulik, 1987)

Media versus methods

The debate in the Educational Technology literature involves two opposing viewpoints. On the one hand are the researchers who hold that the media used to deliver an educational programme can only affect the efficiency of delivery, not the effectiveness of the outcomes. On the other side of the debate are those who support the view that the media such as video, text, computers, audio tapes and broadcast TV can and do impact the effectiveness of the delivery outcomes and should be pursued vigorously for the benefits they deliver.

The primary concern of the "media as efficiency only" proponents is that valuable research resources are being expended on media research that is insufficiently rigorous to differentiate between the learning outcomes caused by the instructional methods used (interactivity, learner centeredness, group learning, etc.) and the media used for the delivery. Because much of the past media research has not controlled sufficiently for the instructional methods variable, the reliability of the results are highly suspect. Clark, a primary supporter of this viewpoint, holds that because there is no way to separate the impact of instructional methods used from the influence of the media used, all such research is confounded (Clark, 1983; Clark, 1994). Proponents of this view assert that the media can have no affect on the effectiveness of the outcomes, any more than a delivery van will improve the nutritional value of the food it delivers. Since they believe in the "media as efficiency only" viewpoint, it then follows that any resources used to research the effectiveness of media represents wasted resources that could be far better spent on instructional methods research instead.

On the other side of the debate, the "media effectiveness" proponents have a concern. They foresee in the near future the convergence of communication technologies and digital computing power. This convergence offers great hope for educational effectiveness (and efficiency). There is the serious danger however that if the "media as efficiency only" viewpoint wins the day, this powerful new medium will be relegated to interactive soap operas and home shopping. Proponents of this viewpoint hold that the delivery vehicle can, and does, impact the effectiveness of the learning outcomes. It is much like the refrigeration truck delivering frozen foods or moving other perishable foods (Reiser, 1994). Without the specialised delivery vehicle, the nutritional value of the food will become seriously degraded. Kozma, a major supporter of the "media effectiveness" view, holds that theories of media effectiveness must "reflect both the capabilities of media and the complexities of the social situations within which they are used" (Kozma, 1994). He goes on to assert that media theories must identify the supporting mechanisms through which cognitive and social processes work in order to more securely establish the connections between media and learning outcomes.

Effective learning systems

Jonessen identifies the cause of the conflict between the "media as efficiency only" and the "media effectiveness" supporters as the traditional scientific theories used to view the debate (Jonessen et al., 1994). The traditional scientific theories subdivide the situation into components, attempt to control some variables so as to measure the results of the other variable(s). This approach ignores the large body of "systems" literature which demonstrates that a system is more than the sum of its parts. Learning systems are not about media or methods, but about learners learning. Those learners will use various methods and various media in complex social settings. It is all of these components working together synergistically that in the end produce learning outcomes. Ullmer (1994) further argues that the reductionist approach to media research, although a technically valid research approach, is incapable of providing insight into the learning process. This is highlighted by Clark's admission (see Ullmer, 1994) that media can have "attitude and engagement possibilities", while rejecting the concept that media can affect learning outcomes in student achievement. Thus Clark seems to say that media can affect student attitude and engagement, but attitude and engagement cannot affect learning outcomes. Jonessen and Ullmer both conclude that a different research approach is needed to measuring the effectiveness of technology supported learning systems.

With valuable insight, Shrock (1994) recognises that in this debate much is available to be learned from the opposition. Clark raises valid questions about research validity and Kozma identifies excellent research methods. The debate is a timely one given the convergence of technologies that are taking place, and a deeper understanding of the potential synergisms is badly needed. As Ehrmann (1995) puts it "As for useful research, we have both the Clark and the Kozma agendas before us: 1) to study which teaching-learning strategies are best...and 2) to study which technologies are best for supporting these strategies."

There are a number of further factors that add to this debate including the transformational nature of media, information richness research and the rise of Constructivism or learner centered approaches to education.

Research on the transformational nature of media predates McLuhan's (1962) work on the historical impact of print media on modern society, our ways of thinking, relating and experiencing life. The example of print media will suffice to demonstrate that "the habit of literacy results not in a preliterate world plus readers, but in a literate world: a new world in which everything is seen through the eyes of literacy" (Levinson, 1989). This naturally raises the question, what will the habit of "computacy" result in? The answer to this is unfolding around us, and the best use of the new media is in the process of being discovered.

Research on information and media richness, media choice and media effects (Rudy, 1996) raises issues of the ability of a given medium to support shared meaning or effectively communicate information or engage the participant in the process. Can it be said that print media has the same effectiveness in supporting shared meaning as face-to-face or video-conferenced communication? The literature does not support this view (Rudy, 1996).

This whole debate must also be considered in the light of the rise of Constructivism as a world view in education, with educational technology coming late to the debate and development. (Duffy, 1992) As a result much of the research and development in earlier educational technology followed the objectivist approach to course design, and has been more reductionist and experimental in nature. Increasingly researchers in educational technology are, however, urging constructivist approaches to both learning system design and research related to these learning systems (Jonassen et al, 1998). Thus there is the need for more in-depth research using a variety of supporting methods to gain a deeper insight into the complex learning process.

Another significant issue to be considered is the setting in which the technology mediated learning system is used. Distance learning and flexible learning are related settings, and these will be discussed in the next section.

Distance and flexible learning

Distance learning is the process of delivering education at a distance, typically in a self-paced, independent study mode (Schreiber & Berge, 1998) and has been widely available most of this century using print media. Often referred to as correspondence education, distance learning can be contrasted with flexible learning. Flexible learning is the term typically used to refer to the process of delivering education to campus based or other students in close proximity to the institution, often by on-line means that allow greater flexibility in time and place for participation in the learning process. The on-line education domain overlaps face-to-face and distance education modes since it has the potential to incorporate time and place independence, and mediated features of distance education with the interactivity and many-to-many features of face-to-face education. (Harasim, 1989) Both flexible learning and distance learning can use these same on-line technologies, but flexible learning often does not share many of the other organisational and social characteristics of distance learning. This section will describe the characteristics and technology considerations for distance and flexible learning.

Characteristics

Students in a distance learning setting are typically adult learners who are very busy, with family obligations, limited time available for studies and restricted funding, thus having to pay their own way. (Hillesheim, 1998; Boston, 1992). Often distance learners fall into two categories: home-based learners and company-based learners. The communication styles of these two groups are different and they respond differently to the three generations of distance learning technologies: (1) correspondence paper based, (2) multi-media distance teaching incorporating broadcast media, cassettes and to a limited degree computers and (3) communication based distance learning with its focus on two way communication using on-line communication methods and interactive instructional materials. (Nipper, 1989) This may be contrasted with the student in a flexible learning setting, where the student is on campus, not isolated, can meet the instructor and other students face-to-face whenever is suits them, but they can also "attend" lectures using digital streamed video, or web enabled course material at a time that suits them.

The need for flexible and distance learning systems is increasing for multiple reasons. These reasons include increased financial pressure on students and institutions as many government funding organisations have cut available funding to the tertiary sector. As a result more of the financial responsibility falls on students, so they have to work more hours in paid employment. This naturally makes it more difficult for many students to attend lectures at fixed times. Related to this problem, given reducing government funding, is the fact that institutions are trying to find more efficient ways to use existing facilities (Nguyen, 1996b), and flexible learning systems offer the potential to reduce the need for more physical buildings, and permit their use more intensively. In addition, issues of life long learning and the need to continuously upgrade professional knowledge in the workplace are increasing the need for distance and flexible learning systems. (Schreiber & Berge, 1998; Eden et al, 1996) The use of this technology to support collaborative teams is also an ongoing topic of importance given the rise of the virtual corporation and need for teams to work together at a distance. (Alavi, 1997)

Technology considerations

There is a range of pros and cons in regard to using on-line technologies in distance and flexible learning systems. On the positive side benefits include:

- flexibility, collaboration support and asynchronous communication (adding flexibility) (Rowntree, 1995),
- 24 hour access, by anyone anywhere, ability to restrict to particular individuals, (Sangster & Lymer, 1998)
- seamless integration of text, graphics, video and sound, direct access to other resources from around the world, most up-to-date material and a low learning curve for creation of simple web pages (Sangster & Lymer, 1998),
- the ability to incorporate interactivity into lessons that are not easily incorporated into the typical paper based distance education programmes, or sometimes even into face-to-face settings. (Eaton, 1996; Rutherford, 1996; Mitrione & Rees, 1998)

However there are drawbacks and concerns as well including:

- technology problems and poorly constructed flexible learning systems (Pennell, 1996),
- the technology doesn't appeal to all students partly because there is the perception of low human contact (Rowntree, 1995),
- new skills are needed by tutors and students and the risk of tutor overload (Rowntree, 1995),

- the potential to exacerbate the existing distance education problem of a high dropout rate due to increased anonymity that can be fostered on the web and thus lack of commitment (Dreyfus, 1998).

- The problem that distance learning via the internet may not be scalable, due to the high one-on-one email necessary to provide a quality learning experience. (Bothun, 1998)

Some of these problems are mitigated in a flexible learning setting as face-to-face encounters are part of the learning mix.

Impact of technology on higher education

The use of computer technology in education has a reasonably long history beginning shortly after World War II with the dreams of some educators to use this new tool of the mind (Kulik et al, 1980). There have been various motivating forces as well as hindering forces in the development and adoption of this technology. This section will consider these motivating forces, the hindering forces and the results of studies on the effectiveness of past efforts to incorporate computer technology into higher education.

Motivating forces

The push to use technology in higher education is often perceived to be from administrators looking to cut costs or create efficiencies in delivering higher education (Smith, 1996). There is some support for this view through research that has been done on the efficiency of various technologies in delivering higher education at a distance (Rumble, 1989; Nguyen, 1996a). This research appears to demonstrate that the mass media (print, audio-visual and broadcast media) based higher education is less expensive to deliver than traditional face-to-face education. This is accomplished by substituting initial capital set up costs for the on-going costs of face-to-face or other interactive forms of communication. Although administrative-push is undoubtedly a factor, an equally powerful motivating force is often demand-pull (Alavi & Yoo, 1997) from students who arrive at University already experienced with the Internet, email and other computer supported technology. These students see technology as a standard part of their educational setting and expect it to be part of the higher educational setting too (Harris et.al., 1998). Peter Drucker, management guru, goes so far as to say that in a few short decades the typical university campus will be a relic of a past age (in MacDonald & Gabriel, 1998). Similar views have been expressed by other educators (Sangster, 1998), some enthusiastic about the prospects and others deeply concerned.

Another major motivating force that cannot be underestimated is the impact of technology push. Given the rapid increase in computing power and the continuing drop in price of this computing power (Alavi & Yoo, 1997) this is a compelling force for adoption of the technology. The inexorable advance of computing power has followed Moore's law (Stair & Reynolds, 1998), that transistor densities on a single silicon chip will double every 18 months. This has meant that we have massively increasing computing power, at a relatively constant cost, that can be dedicated to improving the user interface, not just for delivery of the content. This creates a platform for development of higher-order learning, interactivity and learner centred designs that were not previously possible, not with technology, nor in face-to-face settings, except in one-on-one tutoring. (Leidner & Jarvenpaa, 1993; Soloway & Prior, 1996; Bloom, 1984). Based on this increasing computer power, advanced technology developments such as Intelligent Tutoring Systems (Woolf, 1996; Woolf, 1995; Bloom, 1984) offer prospects for these systems to achieve the 2-sigma effect.

A measurement of the effect of these motivating forces is the rate at which the technologies are adopted by educators. Innovation diffusion researchers point out that the rate of adoption varies considerably by economic sector and country, some sectors and countries tending to be early adopters and others late adopters. A theme that comes through in the literature is the issue of rate of adoption of new learning technologies by educators (Adam, 1996; Moore, 1991, Ives, 1996). By 1995 the regular use of email (80%) had nearly risen to the same level as overhead projector useage (90%) and exceeded the use of fax and VCR technology by academics (Adam, 1996). Early surveys of Internet users showed that the vast majority were young males from high socio-economic backgrounds. However a significant trend has developed indicating an increasing balance across gender and age, although the median income bracket is still quite high (Pitkow & Kehoe, 1996).

Hindering forces

Not all educators are enthusiastic about the use of computer technology in higher education however. Among the problems is one of equity in education, as the need for access to the technology may prohibit some individuals and small companies from using this learning technology (Smith, 1996). Related issues include the fact that not all students do well in a self directed environment which is typical of technology mediated learning, with many preferring the face-to-face setting for the social interaction and the human touch that is typically missing in technology based settings (Smith, 1996). Also of real concern are the pressures the new systems will put on academic staff, perhaps having a negative effect on their research performance. In addition there are issues in the management of the learning process in this new environment that are not always well understood that can have a negative impact on the quality of learning such as potential low contact with instructors and the perception that the student will be treated like a number, only getting feedback from the machine (Nguyen, 1996b; Pennell, 1996).

Delivery issues also affect the ability of technology to impact higher education. Current bandwidth problems on the Internet highlight this. While solutions are on the horizon, solving the bandwidth bottleneck is a crucial factor in maximising the multi-media potential of this distributed medium (Muller, 1996; Nguyen, 1996-a; DeJesus, 1996; Alavi & Yoo, 1997).

Although the work of Rumble (1989) noted that mass media higher education using technology is less expensive to deliver than traditional face-to-face, not all agree. There is a very real concern for the very high cost of creating technology based learning systems, with some estimating 100 hours to create a one hour module, versus conventional training of only 12 hours of preparation (Houldsworth, 1996). This point is in part explained by Rumble, by factoring in the cost of bricks and mortar, repeated delivery and other factors that are part of the face-to-face setting.

Effectiveness of computer technology in higher education

Given the impact on learning technology diffusion of the above motivating and hindering forces, what has been discovered about the effectiveness of computer mediated learning environments?

There have been ongoing research efforts on the impact of technology on higher education using a range of techniques. Unfortunately in the vast majority of the literature, even the experimentally based studies, underlying theory is weak (Charp, 1998; Jones & Paolucci, 1999). Much of the literature is descriptive in nature and does not provide a sound theoretical foundation to build from. That which is theoretically founded has been experimental or survey in nature (Mitrione & Rees, 1998; Papa, 1998). The need for sound instructional design incorporating behavioural and cognitive learning theory is certainly recognised (Cook & Kazlauskas, 1993), but the link to theoretical outcomes not often reported. When studies do link to learning theory to outcomes it is most frequently Bloom, Biggs and Gagne as noted earlier, without the development of more comprehensive theory directly associating technology and learning together (Jones & Paolucci, 1999; Ross & Moeller, 1996; Leidner and Jarvenpaa, 1995). Models related to this conjunction are discussed at the end of this chapter under the heading "Synthesis of technology and effective learning in higher education".

Reported studies cover a wide range of technologies including: collaborative telelearning (Alavi, 1995) with video conferencing, videodisc based museum exhibits (Hirumi et al., 1994), sociology (Schutte, 1997), CBI use in an information systems course (Montazemi & Wang, 1995) as well as various other disciplines from science, math, English, business (Krendl & Lieberman, 1988; Kulik & Kulik, 1987; King et.al, 1990) and nursing (Billings, 2000). There are some exceptions to the experimental approach to this research with more qualitative based research methods being used. Areas in which such research has been done include: distance learning use of teleconferencing (Mason, 1989), teaching EDI and telecommunications in a laboratory setting (Parker & Swatman, 1995a, 1995b), accounting education (Abraham et al, 1987; Gilliver, 1997; Geerts, 1998; Debreceny, 1999) and using an electronic classroom with MBA students (Alavi & Yoo, 1997).

Some specific studies that have had theoretical foundations and their outcomes include:

- The use of computer based instruction to support mastery learning in an information systems course (Montazemi & Wang, 1995), a significant relationship was found between time-on-task and performance, more time meant more learning.

- The use of a computerised practice set in an introductory accounting course (compared to students who did not do a practice set) found no significant difference in student performance or effort but there was a significant difference in improved attitude toward accounting. (Abraham et al, 1987). A descriptive paper by Roufaiel (1988) claimed enhanced learning and productivity from the use of an electronic tutor cum practice set, but provided no evidence to support this assertion.

- The use of computer aided training for learning assembly language (Navassardian et al, 1995) yielded higher scores on tests of declarative knowledge as well as demonstrating more rapid learning of the material.

- The use of computer-intensive studio courses instead of traditional lecture-discussion produced a sharp increase in class attendance and higher ratings on course evaluation. (Ehrmann, 1999)

- An internet delivered graduate engineering management course rated equally well on student performance (ie no significant difference) with a campus, class room based course. The students in the internet based course also rated effectiveness and satisfaction with the course high, in spite of an initial scepticism. (Evans et al, 2000)

- Two tertiary level courses that used a Computer Assisted Learning (CAL) module as part of the course produced contradictory results, with one group of students demonstrating a deep understanding of the course material (using the SOLO taxonomy (Biggs & Collis, 1982))

> while the other group showed only a surface understanding of the course content. Using qualitative methods, the researcher discovered that the CAL module used by students in the group that did demonstrate a deep understanding, was well integrated, easy to use and required deep consideration of the course content while the other CAL module did not. (McAlpine, 1996)

In a major Australian study, Alexander (1999) reports that improvement in student attitudes compared to traditional instruction was one of the most common results (63% of respondents) from a review of 104 government supported teaching development grants, with few reporting (37%) improvement in student learning outcomes. Alexander puts much of this down to poor research method, with student survey's being the most widely used method.

The meta-analytic work summarises the many experiments reported in the literature. This work enlightens the ongoing media versus methods debate discussed earlier and establishes the broader view on learning outcomes from computer assisted instruction (CAI) and computer assisted learning (CAL) application useage. The work of Fletcher-Flinn and Gravatt (1995) indicates that CAI and CAL do produce higher effectiveness in experimental settings with results in the range of 0.24 standard deviation (sigma) improvements for the period 1987-1992 and 0.33 sigma improvements for more recent studies. These results are positive but far short of the hoped for 2-sigma effect (Bloom, 1984), although demonstrating a rise in the efficacy as newer technologies were introduced more recently. This confirms the results found by previous researchers (Kulik et al, 1980; Kulik & Kulik, 1987; Krendl & Lieberman, 1988), but raises the question of whether newer technologies, capable of better supporting the constructionist world view on education are more efficacious.

Although these researchers do report overall positive results, this view is not universally held. Lockee reports that many educational technology studies, especially distance education, report no significant difference between learning outcomes in the traditional classroom and technology supported distance learning (Lockee et al, 1999). Clark and his many supporters agree with this "no significant difference" view, as noted in an earlier section of this chapter on the "media versus methods" debate.

Ehrmann (1999) reports on an English compositions class which demonstrated no difference in learning and higher cost in the computer labs due to smaller class sizes in the limited space computer labs. Dillon and Gabbard (1998) reported similar uninspiring results in their review of the hypermedia literature in the context of educational technology. A common theme among these less positive studies is the importance of studying not just the media, but the methods and real world context of the learning environment (Bryant & Hunton, 2000). This certainly supports the direction pointed in the Media versus Method debate section earlier in this chapter.

The issue of how to achieve the most efficacious results for higher education learning outcomes is also addressed by the work of Laurillard (1993) in discussing the need to structure higher education materials when using technology so as to maximise student benefit. Among the key factors pointed out include the need to provide structure, interactivity, feedback and reflection (Gilbert, 1996). Related concepts include goal based scenario and problem based learning (Schank, 1996) in which a scenario or problem description provides motivation, context, specific challenges and access to information. The intended outcome is that learning, doing and assessment are integrated, rather than the more traditional approach of compartmentalising these learning functions. Encouragement to develop systems that promote analytical thinking and problem solving skills is suggested by others (Borthick & Clark, 1987) in developing deeper learning outcomes. Further consideration can also be given to issues raised by brain based educational research in considering the impact of interactivity and multimedia on biochemical changes that occur in establishing memory through interactivity (Simpson, 1994; Jensen, 1996).

An additional significant area that arises when discussing effectiveness of computer technology is the area of collaborative learning. The potential to support group collaboration within single institutions and across multiple institutions creating new learning opportunities has been demonstrated effectively by Alavi and others (Alavi, 1995; Wheeler et.al., 1995; Jones, 1996). The use of computers and tele-communication systems have been used in an international collaborative learning environment to internationalise the curriculum as well as enriching Technology in Teaching and Learning research (Parker & Swatman, 1994;). In addition the important potential of using these systems to gain the significant benefits of building a community of colloborative learners (Scardamalia, 1996) has been considered. Alavi (1994) conducted an empirical evaluation of a computer-mediated collaborative learning system and found higher levels of self-reported learning and evaluation of the classroom experience in comparison to traditional lecture format. She also found that students performed significantly better on the final test for the course. At the University of Maryland, College Park, Shneiderman, Alavi and other colleagues have worked with fully equipped electronic classrooms that support both small group collaboration and whole class collaborative learning. (Shneiderman et al, 1998) Courses at the University of Maryland that have used electronic classrooms have covered a broad spectrum of disciplines from the arts and sciences, engineering and business involving over 74 faculty members and 264 courses.

Of further concern in the effectiveness of computer technology in higher education learning settings is the issue of engagement. Norman and Spohrer (1996) assert that an "engaged student is a motivated student... which correlates well with time-on-task..." But will an engaging technology based learning environment actually engender higher time-on-task? The meta analytic work of Kulik and Kulik (1987) would suggest that the opposite is true, that students spend less time-on-task, but learn as much or more (compared to control groups in a traditional learning mode).

Research Paradigm's

A wide range of research paradigm's have been used in the field of educational technology, as noted earlier in this section. Another way to look at these paradigm's is through the matrix of research paradigms presented by Leslie J. Briggs for use in the field of Educational Technology (Briggs, 1982; Driscol and Dick, 1999). This matrix describes four research cultures, including:

> Culture One: researchers considered learning in the context of retention of non-meaningful material under the assumption that learning untainted by prior knowledge would yield a more pure understanding of the learning attainment.
>
> Culture Two: researchers considered learning in the context of retention of meaningful material constructed to exhibit particular characteristics, but

typically only short prose passages, with little resemblance to real classroom material.

Culture Three: researchers considered learning in the context of real school curricula, but did not contain objectives classified according to an accepted taxonomy such as Bloom's (cognitive) or Gagne's, nor designed to achieve specific learning goals. Biggs considered this to be the culture most prevalent at the time he first posited his matrix of cultures.

Culture Four: researchers had to meet four key criteria: (1) student learning considered in the context of real curricula, (2) accurately classified learning outcomes using an accepted taxonomy such as Bloom's or Gagne's, (3) the study materials should be systematically designed and formatively evaluated using a recognized instructional design model and (4) the instruments used to assess learning in the research must correspond to the identified learning outcomes in the instructional materials.

Furthermore Kozma (2000) suggests a possible Fifth Culture: one incorporating (1) a new context of the researcher having a deep understanding of the needs, goals and issues of students and teachers in the learning environment under study, (2) a focus on design of learning environments created by the learners rather than design of instruction for some faceless student, and (3) a deeper understanding that the medium shapes the way instructional technology designers think, conceptualise and do; both enabling and constraining design of learning systems.

This section has considered the general impact of computing technology on higher education including issues of effectiveness. The next section will look more closely at the newest of these technologies, the Internet.

The Internet and higher education

The rise of the Internet to prominence on the technology horizon during the 1990s has raised the question of its potential as an educational medium, and the influence that it might have on the future of higher education. There is currently much work being done to experiment with the use of this technology in delivering educational programmes (Aoun 1996, Bearman 1996, Bytheway 1996, Eden et al 1996, Galegher and Kraut 1994). However there has been very little work done to date on the effectiveness of this medium (Harris, 1998; Borras, 1998). This is one of the factors giving rise to the current study.

As in the previous section, this section will consider the motivating forces, hindering forces and issues regarding the effectiveness of the Internet technologies to support higher education.

Motivating forces

The ubiquity, multi-media capabilities and ability to support both synchronous and asynchronous communication are major forces in considering Internet technologies for use in higher education (Alavi et al, 1995; Benjamin & Wigand, 1995; Ives & Jarvenpaa, 1996). These characteristics support a number of new directions in higher education including support for greater interactivity in the learning process, providing greater equity of access to higher education, support for just-in-time learning and development of the concept of an international community of learners.

There is considerable potential to overcome some of the drawbacks of traditional residential, lecture based teaching which is typified by one-way communication and based on a transfer of theoretical knowledge, by using interactive Internet technology to engage the student in constructing authentic knowledge of a subject area (Eaton, 1996; Ells, 1997; Laurillard, 1993; Nguyen, 1996a; Kozma, 2000).

Internet technologies offer very real potential for greater equity in higher education, meeting the needs of the isolated, handicapped, full time working people, those with family responsibilities and life long learning for the population as a whole (Alexander, 1999; Hutchison, 1995b). Naturally with this potential comes the related need to provide these students with training in the use of the technology and equity of access to the computer systems so necessary to make use of the potential (Jones, 1996). A corollary to this is that higher education teachers and professors also need to learn the best use of the technology, if it is to have a lasting and positive impact on education (Soloway, 1996; Ells, 1997; Laurillard, 1993).

The ability to determine the impact of educational technology on learning outcomes, to discover the effectiveness of varying combinations of technology and pedagogy present an important recent theme in this literature (Evans et al, 2000; Kozma, 2000; Billings, 2000).

A significant development in higher and continuing education is the issue of just-in-time learning. Both employers and educators are painfully aware of the rapid pace of change and the need for continuous learning (Eden, 1996). The half-life of much of higher education is now rather short and the potential to deliver learning throughout the individual's life is becoming increasingly necessary. This trend runs contrary to the traditional view which posits that a person should first get an education and then when their education is complete, find a job (Hamalainen et.al., 1996). In order to carry out this vision of just-in-time learning, students need to learn both new disciplinary content and how to use the technology. A valuable development has been the recognition that students can develop the technology skills in searching and even building web sites, while learning about Marketing, Information Systems or English as a second language (Ives & Jarvenpaa, 1994; [HREF 5]).

Another motivating force for using the Internet as part of the educational platform is the concept of an international community of learners. The ability to use annotations on-line to comment on each other's work (Rutherford, 1996), work on joint projects supported by email and threaded discussion and workflow features (Alavi & Yoo, 1997) and participate in virtual visits (Hutchison, 1995a) thus permitting educators and students to construct knowledge through discourse in a community of learners. This concept of a world wide community of learners offers exciting opportunities that do not exist in the typical face-to-face classroom.

Hindering forces

Although there are some strong motivating forces, there are also significant hindering forces reacting to the new technologies. Among these hindering forces are:

- concerns for possible loss of quality in education,

- increasing competition through Virtual Campus concepts undermining the viability of some institutions,
- a lack of understanding regarding new distribution methods for virtual learning materials,
- issues of reliability and confidentiality on the cyber-campus
- the lack of sufficient instructional designers and knowledgeable faculty to support new initiatives.

There is considerable concern among those involved in teaching in higher education that administrators and funding agencies see the Internet as a way to improve faculty productivity. They are worried that in the rush to cut the cost of higher education, technology will be substituted for qualified academic staff and quality will suffer significantly (Harris et.al., 1998). Quality issues such as lack of social and instructional contact between students and academic staff (Rowntree, 1995; Smith, 1996; Soloway, 1996) and greater difficulty in enculturating new students into the institutional ethos (Borenstein et al, 1996; Rudy, 1996). Additional quality issues include the potential for using the technology to simply deliver more information thus resulting in information overload (Rudy, 1996) and the problem of developing or maintaining student motivation and commitment using impersonal Internet technologies (Dreyfus, 1998).

Internet technology use in higher education also raises the potential level of competition through distance education. The Internet technologies are removing barriers to entrance into new markets, both local and international. Over the past few years there has been an explosion of higher education institutions developing Virtual Campus offerings, essentially making their courses available via distance learning, supported by Internet technologies. The viability of small institutions in the face of competition from larger and better endowed institutions (Benjamin & Wigand, 1995; Hamalainen, 1996) is seriously threatened by these new levels of competition. A corresponding competitive concern is the question about the ways in which information will be created and distributed. This has a potentially serious impact on traditional textbook publishers, the funding models they will use, management of quality of the learning materials and the sustainability of such knowledge vendors (Benjamin & Wigand, 1995; O'Reilly, 1996).

Issues of reliability and confidentiality also arise when speaking of the Virtual University (Borenstein et al., 1996). Bricks and mortar institutions are there everyday, the professors and students show up and education occurs. But if the information highway is too clogged, a server is down or there is a local power outage, then the Virtual Campus may be closed for business, or delivering very poor levels of service. The same is true for issues of confidentiality and authentication (Hamalainen, 1996). Are the electronic communications secure for highly confidential information such as student grades and financial information? Are they secure from hackers? How can teachers be sure that the student taking the virtual course is actually the one they claim to be?

In addition there is the need for a solid base of multi-media instructional and design specialists to be trained in the tertiary sector, in some cases using the web as the means of instruction as well as the subject of instruction (Oliver & Omari, 1996). Many faculty would like to use technology effectively, but do not know how. Sangster and Lymer (1998) encourage accounting educators to make use of the plethora of resources now available on the web to support their own developments.

Effectiveness issues for the Internet in higher education

A range of issues arise when considering effectiveness in the use of Internet technologies in higher education. Previous work on the use of the Internet in higher education has been largely descriptive in nature with some limited evaluation work, mostly of the survey style and has included access to resources, communication issues, the impact of student control in a hypertext environment and incorporating interactivity into the educational approach.

Boalch (1996) describes his use of the Internet to give students access to course materials (outlines, assignments, answers to review questions and lecture notes) as well as email communication with a tele-commuting tutor. Students expressed a high level of satisfaction with accessing course materials from the Internet in comparison to the paper version. 94% found the Web site useful, while only 18% found the paper version of the course outline more useful. However the number of accesses per week showed a steady decline after the first few weeks of the term. This information was based on server statistics and a survey conducted with a sample of the students. 56% of students expressed an interest in doing more of their study from home using the Web based material due to the flexibility it offered. Based on anecdotal evidence students appreciated the ability to use email to contact the tele-commuting tutor, arranging meetings and asking questions using email.

In looking at incorporating greater student control in a hypertext learning environment, Eaton (1996) describes efforts at his institution to strengthen student learning. Using CGI scripts within the web based distance learning setting they attempted to increase the amount of interaction in various categories including: content, pace, feedback, and context or situational control. They also attempted to increase the amount of social interaction. Rethinking the use of multimedia so as to fill a more ambitious role than is currently the case is urged by Laurillard (1995) including, support for discovery learning and guided discovery learning as well as supporting other approaches due to it being an adaptive medium.

Eklund and Eklund (1996) describe their research in comparing the experience of students in two very diverse courses at two different institutions. One group had a computer science background the other group was taking an introductory course in computer literacy. He describes the process of incorporating interactivity and constructivist style learning processes into a web enabled course across two Universities. Results of the comparative evaluation, based on student surveys and some qualitative evidence from instructors' reports indicate students enjoyed the web approach and found the learning effective.

Taking a broader approach at her institution, Gilbert (1996) describes the process of bringing together individual academics who wish to improve their teaching and consequently more effective student learning. She describes the various constructivist approaches to incorporating web based technologies into a wide range of courses. Emphasised is the need for staff development and a sound infrastructure from which to build these systems and permit staff to experiment with various approaches. This is supported by Ells' work (Ells, 1997) in providing instruction to tertiary educators in the effective combination of web technologies and sound pedagogy.

In the following section the comprehensive theoretical study by Leidner and Jarvenpaa (1995) is considered, bringing together the range of pedagogical issues and technology uses into a cohesive theoretical model.

Synthesis of technology and effective learning in higher education

The development of comprehensive theory models incorporating both learning theory and technology elements is a recent and much needed trend. These developing models provide a more secure foundation for researchers to build reliable and useful studies of learning effectiveness on. This section will look at three of these models including the work of Leidner & Jarvenpaa (1995), Jones & Paolucci (1999) and Ross & Moeller (1996)

The work by Leidner & Jarvenpaa (1995) provides a comprehensive taxonomy, that largely subsumes much of the earlier learning effectiveness literature as well as adding the technology dimension. Aspects covered in Figure 2-4 under the Process Dimensions include learner control over pace and content and objectivist (also called instructionist) versus constructionist approaches to learning. These two models, called Objective and Constructive in Figure 2-4 represent the most common poles of the larger framework in learning theory, with the Objective model representing the left side of Figure 2-4 and Constructive model representing the right side of Figure 2-4. Leidner includes a number of other learning models as well, including collaborativism, cognitive information processing and socioculturalism. These later three models are in many ways children of the constructionist model.

The Objective model is based on stimulus-response theory and the concept that the objective world can be communicated accurately as factual and procedural knowledge disseminated by instructors expert in the field of study. The objective model is typically implemented using the lecture method of teaching and tends to focus on the lower order cognitive objectives from Bloom's taxonomy.

The Constructive model on the other hand assumes that learning consists of individuals constructing knowledge based on the learner's experience and personal viewpoints. This construction of knowledge involves the higher levels of Bloom's taxonomy of cognitive objectives and is typically implemented using "learner centered" approaches involving discovery, control of pace and content, investigation, case analysis and other similar learning experiences.

Although Leidner's work, as summarised in Figure 2-4, presents a polarity of these two models, the work of Ramsden (1992), Hammersley (1986) and Brown and Atkins (1988) support the view that both models may work depending on the instructional goals and a combination of the models may prove suitable in other learning situations. However the consensus amongst most researchers in the higher education field appears to be that "learner centered" approaches arising from a moderate constructivist viewpoint are proving to produce the best results for both factual learning and higher order thinking (Ramsden, 1992).

Leidner's work also summarises the use of Information Technology (IT) in the classroom ranging from:

- Automating using Instructor consoles with presentation software like Powerpoint, Computer Assisted Instruction (CAI) and Computer Based Training (CBT) and some distance learning regimes;

- Informating up using keypad response systems to give instructors feedback from students during lectures, also the use of email to allow students to ask questions of instructors in a non-threatening and time independent way;

- Informating down involving learning networks where students gather, explore and share information, these learning networks may involve hypermedia including the World Wide Web, virtual reality and simulations, as well as communications classrooms using networks to support student learning, information sharing and distance communication for case analysis; and

- Transforming, using Virtual learning spaces involving asynchronous communication with students participating in the learning processes when they want for as long as they want.

	AUTOMATING	INFORMATING UP	INFORMATING DOWN	TRANSFORMING
Technology	Instructor Console CAI/CBT Distance learning	Keypad Response Instructor-Student email	Learning Networks Virtual Reality Simulations	Virtual Learning Spaces
	Instructor Console and Student Workstations		Communications Classrooms	
Classroom Structure	Hierarchy/Tree	Star	Ring	Dynamic
Model	**Objective**	Objective, Cognitive IP	Constructive, Cognitive IP Collaborative	Collaborative, Cognitive IP Sociocultural, **Constructive**

PROCESS DIMENSIONS

Instructor ←	Control of Pace, Content	→ Student
Knowledge Dissemination ←	Purpose of Instruction	→ Knowledge Creation

OUTCOME DIMENSIONS

Ephemeral ←	Impact on Self-Variables (motivation, interest, self-efficacy)	→ Long-term
Factual Procedural ←	Impact on Levels of Learning	→ Conceptual
Lower-order Thinking ←	Impact on Cognition	→ Higher-order Thinking
Low ←	Impact on Behaviour-participation and attention	→ High
Improvements on Factual/ Procedural tests ←	Impact on Behaviour-performance	→ Improvements on Conceptual Assessments

Figure 2-4: Taxonomy of the impact of IT on learning

(from Leidner & Jarvenpaa 1995)

Jones & Paolucci (1998) take an instructional system design approach to educational technology evaluation, providing a systems view of the components that should be considered when constructing and evaluating a technology mediated learning environment. Figure 2-5 provides a summary of the elements Jones & Paolucci incorporate into their model. This model shows the inputs (learning domain, learner profile, and tasks), the processing through a delivery system (locus of control, presence, media and connectivity), and its impact on output of learning outcomes as expressed by Bloom's taxonomy. This model overlaps the Leidner & Jarvenpaa model considerably, primarily in the Process Dimensions and Outcome Dimensions. The primary difference is in the area of Jones & Paolucci's Delivery System section, which is dealt with by Leidner & Jarvenpaa in the Technology, Classroom, Models portion of their model, but covered in a different way.

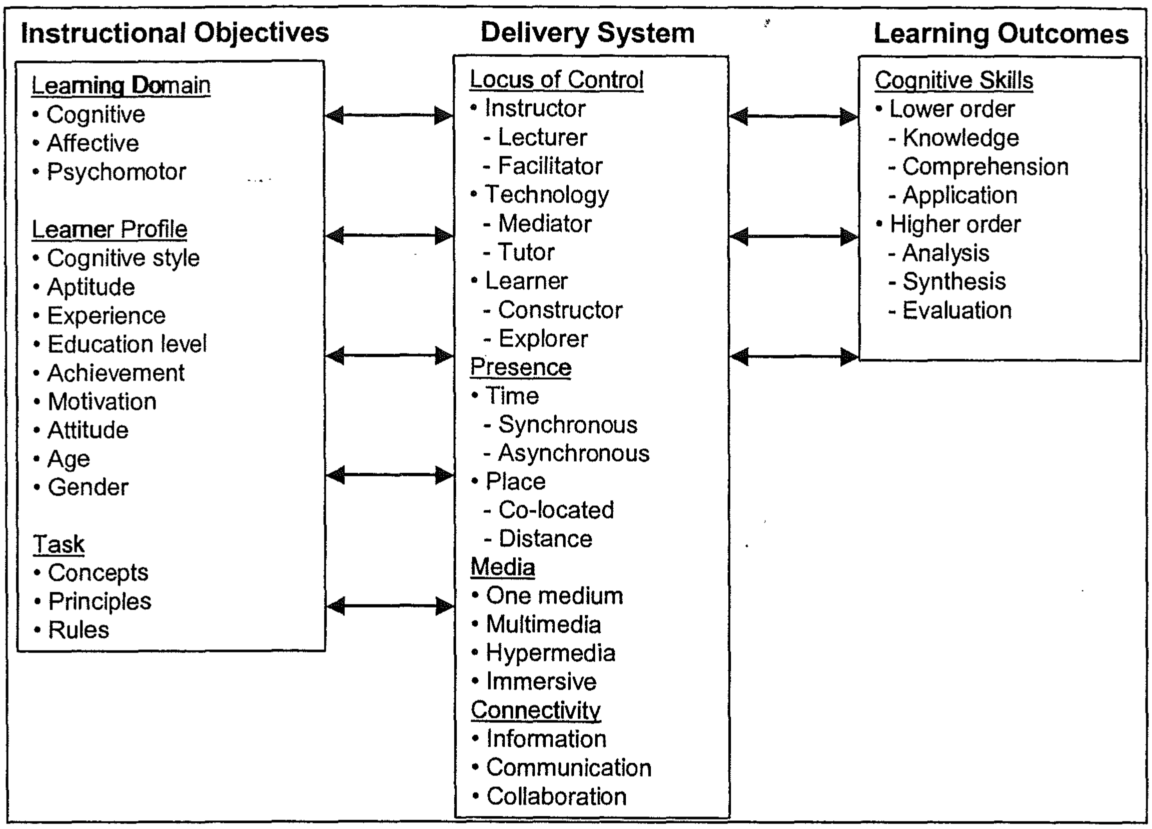

Figure 2-5: Research dimensions and framework for evaluating the effectiveness of educational technology on learning outcomes

(From Jones & Paolucci, 1998)

Ross & Moeller's model focuses on the early design stages of technology mediated learning systems, and thus is more limited in its scope when compared to the previous two models. It incorporates (as seen in Figure 2-6) audience analysis, goal analysis and control analysis. This model overlaps the instructional objectives and delivery system parts of the Jones & Paolucci model and the process dimensions of Leidner & Jarvenpaa's model. The Ross & Moeller model is largely subsumed by either of the two previous models

Audience Analysis	Goals Analysis	Control Analysis
Prior learning	Task analysis	Complete computer control
Learning strategies	- Learning tasks	- No student control of pace
- Accommodator	- Subject matter experts	- No student control of sequence
- Assimilator	- Full content comprehension	Adaptive computer control
- Converger	Requirements analysis	- Student performance modifies sequence
- Diverger	- Learner prior knowledge	- Student control over pace
Ergonomics	- Learner information needs	- Feedback important feature
Attitude toward CBI	- Information requirements	Complete student control
- Motivation	- Other system requirements	- Full student control over pace and sequence
- Cooperation		- Prior knowledge important
- Interface design		- No guarantee all material will be covered
- Training on system		

Figure 2-6: Key features in design of technology mediated learning systems

(From Ross & Moeller, 1996)

These three models overlap in varying ways and a further discussion of these models is carried out in Chapter 8, comparing them to the theory model developed and used in the current study.

Conclusions drawn from literature survey

Stohr (1995) suggests that computers and communication networks may well revolutionise the business of education, so it is crucial for us to understand sound pedagogy if this revolution is to be productive rather than destructive. Ives and Jarvenpaa (1996) assert that the Internet "will transform business education, although not necessarily its traditional supplier, the business school". They go on to suggest that this transformation will occur for both effectiveness and efficiency reasons in the marketplace and the slow response of Universities to this transformation may well endanger their control of business education. But does the Internet provide a good delivery vehicle for effective education, and if so, why?

Bloom (1956) presents a taxonomy of educational objectives ranging from the learning of surface facts to deeper objectives such as synthesis and evaluation. Ramsden (1992) and others suggest that effective education is based on deep learning which covers the full range of cognitive objectives, and this type of learning must be learner centred, active and in context. Are the Internet based technologies capable of

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providing a platform for such learner centred education, and what are weaknesses in filling this role?

Finally Leidner and Jarvenpaa (1995) place the Constructivist based, l educational systems at the "deep" learning end of a Taxonomy of impa learning. They further suggest that virtual learning spaces are the technology element to support these deep learning activities in a Transforming vision of business education. How well suited are the Internet technologies to providing "virtual learning spaces"? They in particular state:

> "Perhaps the most widely known hypermedia tool in academic circles is the World Wide Web,...although we are unaware of research that examines the potential of the WWW in the context of classroom analysis...research examining uses of the Internet and WWW is much needed." (pg. 277)

Further, of the many studies done on the effectiveness of technology in support of quality learning, many have been quantitative in nature (Morrison, 1994, Kozma, 1994) but often poorly linked to theory. Very few have been done in depth and in context so as to explain the supporting links in real life situations (Yin, 1994, Jonassen et al, 1994). The complex nature of real learning environments demands a more holistic approach to research on the interaction of technology, learning methods, students' perceptions and their environment.

The next chapter, Chapter 3, describes the research design for this study. It is intended to respond to the research needs highlighted by the literature in terms of research method as well as addressing the issue of the Internet as a sound foundation for more effective higher education learning systems.

Chapter 3: Research Design

Introduction

The research design for a study provides the blueprint for carrying out the study, achieving the study objectives, and providing the necessary quality controls to assure a successful piece of research, regardless of the outcomes of the study.

This chapter will describe the research objectives, which are intended to establish a supporting chain of evidence as well as being formative in nature. Formative in the sense that some of the outcomes are intended to provide a foundation from which to form theory and practice in future studies and learning system designs. The research design as laid out in this chapter is intended to meet those objectives. In the light of the literature surveyed in the previous chapter, the design will be a multi-method case based design, the choice of which is supported in this chapter. The methods include qualitative processes as well as quantitative ones.

This chapter is structured as follows:

- Research question and hypotheses to be addressed
- Choice of research method
- Design of case study protocol and overall method
- Outline of data analysis
- Design of Web enabled course component
- Outline of analysis chapters
- Summary

Research question and hypotheses

The issues to be addressed in this research spring from three primary sources:

1. Research and theory of effective learning and its impact on accounting students' learning needs.

2. The debate on "the relative importance of media attributes versus instructional methods" (Jonassen et.al. 1994) in determining the effectiveness of an instructional system.

3. Research on the use of technology support for higher education.

This current work aims at a synthesis of these three streams of research. This study used qualitative in-depth case study work supported by experimental and survey quantitative evidence to uncover the supporting nature of educational systems and the effectiveness of Internet based technologies to support higher education. As such this study is formative in nature, intending to provide guidance for future improvements in theory and practice.

This work intends to address the following research question:

> "Do World Wide Web (WWW or Web) technologies provide a pedagogically sound foundation on which to build more effective higher education systems, and why or why not?"

Hypotheses of the study

This research question will be dealt with through a number of hypotheses. These hypotheses are listed below and then discussed further in the light of the supporting literature covered in Chapter 2 and the research Model seen in Figure 3.1.

<u>Primary Hypothesis:</u>

1. Present and near term Web based technologies provide a pedagogically sound foundation on which to build more effective educational systems.

<u>Supporting Hypotheses:</u>

2a. Regarding student process variables of control, feedback and in-context learning:

i) A WWW enabled course is capable of supporting higher student <u>control</u> over the learning environment, as compared with a traditional face-to-face learning environment,

ii) A WWW enabled course is capable of supporting improved <u>feedback</u>, compared with a traditional face-to-face learning environment,

iii) A WWW enabled course is capable of supporting greater <u>in-context learning</u>, as compared with a traditional face-to-face learning environment,

2b. Regarding student engagement variables of attitude towards course content, attitude towards the learning environment and time-on-task:

i) A WWW enabled course is capable of supporting a better attitude towards the course content, as compared with a traditional face-to-face learning environment,

ii) A WWW enabled course is capable of supporting a better attitude towards the learning environment (computers), compared with a traditional face-to-face learning environment, and

iii) A WWW enabled course is capable of supporting higher time-on-task, as compared with a traditional face-to-face learning environment,

3. The student process variables will influence a higher level of student <u>engagement</u> in the learning process. This involves:

a) Better attitude towards the course content, as affected by control, feedback and in-context learning and

b) Better attitude towards the learning environment (computers), as affected by control, feedback and in-context learning and

c) Higher time-on-task, as affected by control, feedback and in-context earning.

4a. Higher levels of student process support (control, feedback and in-context learning) will yield more effective learning involving better performance on tests, including deeper learning.

4b. Higher levels of student engagement in the learning process will yield more effective learning involving better performance on tests, including deeper learning.

The following discusses the supporting literature from which these hypotheses are drawn, with each section numbered in line with the hypothesis above.

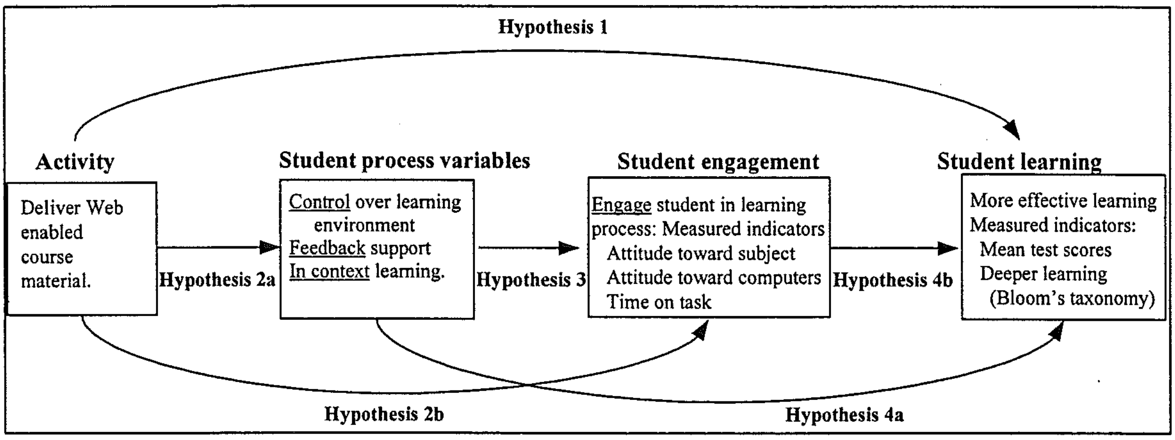

Figure 3-1: Research model for Web supported student learning systems

1. Primary hypothesis:

Leidner and Jarvenpaa (1995) recommend that "Early research in the area of learning improvements that may be facilitated with information technology is thus needed..." (p266) and "Although we are unaware of research that examines the potential of the World Wide Web in the context of classroom analyses... research examining uses of the Internet and the WWW is much needed." (p. 277) In addition the debate over the impact of learning media versus learning methods has Clark asserting that the learning environment could not affect the learning outcome (Clark, 1983; Clark, 1994). The primary hypothesis of this study, that Web technologies provide a pedagogically sound foundation for more effective educational systems, was designed to test Clark's assertion in a systemic way while supporting Leidner and Jarvenpaa's recommendations.

The Research Model given in Figure 3-1 shows this as Hypothesis 1, connecting the Activity of the Web enabled course with Student learning, since system effectiveness is fundamentally about what and how students learn.

2a (i). Supporting hypothesis: web course support for student control

One of the key process dimensions highlighted by Leidner and Jarvenpaa (1995) (see Figure 2-4) is the student control dimension. They stated that one of the assumptions of CAL (Computer Assisted Learning) was that it provided better student control. Creating a learning environment where students have more control and more interactivity is purported to create more effective learning (Eaton, 1996; Eklund, 1996; Laurillard, 1993). These issues gave rise to Hypothesis 2a (i), that a web enabled learning environment was capable of supporting higher student control. Figure 3-1 shows this as Hypothesis 2a connecting the Activity of the Web enabled course with the Student process variables including control over learning environment.

2a (ii). Supporting hypothesis: web course support for feedback

Laurillard (1993) asserts that one of the key elements to effective learning systems is providing formative feedback, this is strongly supported by the work of Angelo and Cross (1993). Leidner and Jarvenpaa (1995) concur with this assertion in reviewing the assumptions of CAL. This gave rise to Hypothesis 2a (ii), that a web enabled learning environment was capable of supporting improved feedback. Figure 3-1 shows this as Hypothesis 2a connecting the Activity of the Web enabled course with the Student process variables including feedback support.

2a (iii). Supporting hypothesis: web course support for in-context learning

One of Laurillard's four key elements to effective learning is structuring the knowledge (Laurillard, 1993). This process of creating structure may involve placing the material to be learned in its real world context (Leidner and Jarvenpaa, 1995; Ramsden, 1992; Entwistle, 1983) such as using contextual problem solving and looking at the learning setting in creative and situated ways (Michalko, 1991). Related concepts include goal based scenarios and problem based learning (Schank, 1996) in which a scenario or problem description provides motivation, context, specific challenges and access to information. It is suggested by the literature that presenting the material to be learned in its context will enhance deeper learning. These issues gave rise to Hypothesis 2a (iii), that a web enabled learning environment was capable of supporting greater in-context learning. Figure 3-1 shows this as Hypothesis 2 connecting the Activity of the Web enabled course with the Student process variables including in-context learning.

2b (i). Supporting hypothesis: web course influence on attitude towards subject

Leidner and Jarvenpaa (1995) consider attitude in the outcome dimension of their theoretical model under the headings of motivation, self-efficacy, and attention. This is founded on the work of Bloom and others in considering learning effectiveness to include both content learning and attitude change (Bloom, 1956; Bowden & Marton, 1998). These issues gave rise to Hypothesis 2b (i), that the web enabled learning environment will positively influence student attitude towards the subject matter of the course. Figure 3-1 shows this as Hypothesis 2b connecting the activity of the Web enabled course with student engagement including attitude towards the subject being studied.

2b (ii). Supporting hypothesis: web course influence on attitude towards learning environment

Attitude towards the content area is one dimension of attitude, the other that was hypothesised was in regard to the attitude towards the learning environment. Fletcher-Flinn and Gravatt (1995) suggested that students' attitudes toward computers should be an important factor. This gave rise to Hypothesis 2b(ii), that the web enabled learning environment will positively influence student attitude towards the computer based learning environment. Figure 3-1 shows this as Hypothesis 2b connecting the activity of the Web enabled course with student engagement including attitude towards computers.

2b (iii). Supporting hypothesis: web course influencing higher time-on-task

Norman and Spohrer (1996) assert that an "...an engaged student is a motivated student...which correlates well with time-on-task...". However Kulik and Kulik (1987) suggested that the opposite would be true, that students in computer mediated learning environments would spend less time-on-task. Hypothesis 2b (iii) was written to differentiate between these two contrary assertions, stating that the Web enabled learning environment will positively influence student engagement in the learning process and will result in higher time-on-task. Figure 3-1 shows this as Hypothesis 2b connecting the Student process variables with student engagement including time-on-task.

3a. Process variables influence on attitude towards subject

While Hypothesis 2b covers the direct effect of the Web enabled course on student attitude and time-on-task, the indirect effect of the student process variables influence on engagement variables is covered by hypothesis 3, as seen in Figure 3-1. The background theory reviewed above for Hypothesis 2b is equally pertinent to Hypothesis 3 and is not repeated in this section.

Hypothesis 3a, states that the student process variables of control, feedback and in-context learning will positively influence student engagement in the learning process, in particular they will result in a better attitude towards the course content. Figure 3-1 shows this as Hypothesis 3 connecting the Student process variables with student engagement including attitude towards the subject being studied.

3b. Process variables influence on attitude towards computers

Hypothesis 3b, states that the student process variables of control, feedback and in-context learning will positively influence student engagement in the learning process, in particular they will result in a better attitude towards the computer based learning environment. Figure 3-1 shows this as Hypothesis 3 connecting the Student process variables with student engagement including attitude towards computers.

3c. Process variables influence on higher time-on-task

Hypothesis 3c, states that the student process variables of control, feedback and in-context learning will positively influence student engagement in the learning process, in particular they will result in higher time-on-task. Figure 3-1 shows this as Hypothesis 3 connecting the Student process variables with student engagement including time-on-task.

4a. Student process variables influence on more effective learning

Leidner and Jarvenpaa (1995) suggest that on the outcome dimensions of Levels of Learning and Cognition that higher-order thinking and more conceptual understanding would be associated with greater student control. This equates to concepts of deeper learning that are supposed to be associated with more control, better feedback and more in-context learning (Laurillard, 1993; Ramsden, 1992; Entwistle, 1983). This literature gave rise to Hypothesis 4a, that higher levels of student process support (control, feedback and in-context learning) will yield more effective learning involving better performance on tests, including deeper learning. Figure 3-1 shows this as Hypothesis 4a connecting student process variables with student learning.

4b. Student engagement influence on more effective learning

The literature given earlier to support Hypothesis 2b (i), (ii) and (iii) also supports Hypothesis 4b, that higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning. Figure 3-1 shows this as Hypothesis 4b connecting student engagement with student learning.

Formative issues and effective learning

A key outcome of this research is the results of the formative analysis, which produced recommendations for modifying the initial design, in order to produce better results in future course designs.

A critical factor in dealing with these hypotheses is the issue of what Hypothesis 1 means by "effective educational systems". This research will consider the term "effective" as including:

- Improved attitude towards the content being learned and the environment of learning, which are treated as the engagement variables in this research
- Better performance on tests
- Deeper learning as measured using Bloom's taxonomy of learning objectives (Bloom, 1956)

These can be seen in Figure 3-1 as Student Engagement and Student Learning. A further discussion of "effectiveness" may be found in Chapter 2.

The research design is intended to test the above hypotheses and confirm or deny the hypotheses. Furthermore it is intended to be both formative and explanatory in nature and so there is a need to establish a supporting chain of evidence in the learning environment.

Choice of research method

The choice of research method is important in accomplishing the overall objectives of any research programme. In selecting a research method it is necessary to consider both what outcomes are intended and the likelihood of achieving them with a given research method. So the choice must be guided by the nature of the research question, the desired outcomes, the demands of the literature and the theoretical framework in which the work will be carried out.

Kozma (Kozma, 1994, pg.14) asserts that media theories must identify the causal mechanisms through which cognitive and social processes work in order to more securely establish the connections between media and learning outcomes. But there is a substantive need to study learning systems, including the methods, technology and outcomes, in their real life context with all its complications and rich experience (Jonessen et al., 1994). The in-depth, qualitative, research approaches are often viewed as running counter to the traditional "scientific" experimental approaches.

The vast majority of the studies done on the effectiveness of technology in support of quality learning have been of the quantitative experimental nature or survey based (Morrison, 1994). Very few have been done in depth and in context so as to explain the causal links in real life situations (Yin, 1994, Jonassen et al, 1994). In addition weaknesses in the design of some of this prior work has failed to clearly establish supporting links. They simply demonstrated that the treatment did affect the outcome under study, without establishing how or why, thus frustrating formative objectives that might allow such research to inform and guide future work (Campbell & Stanley, 1963; Mohr 1995 and Chen 1990). The complex nature of real learning environments demands a more holistic approach to research on the interaction of technology, learning methods, students' perceptions and their environment.

In summary, a research method is needed that will permit study of the learning phenomenon as a contemporary event in its rich, real world context, while at the same time permitting sound assertions about the supporting nature of the relationships.

The theoretical model shown in Figure 3-1 provides an additional guide to the selection of the research method. This model describes the expected interactions between the activity of delivering WWW enabled course content and the final learning outcome of more effective learning. The model hypothesises this will occur through the medium of student process variables (control, feedback and in-context) producing higher student engagement which then yields a positive impact on self variables (attitude towards accounting, attitude towards computers and time-on-task).

In considering the range of possible research strategies Figure 3-2 will prove helpful. A research method capable of providing both an in-depth view on contemporary events and the ability to establish causality are required by the literature and the research question. By inspecting Figure 3-2 it can be seen that experimental, survey and case study forms of research offer prospects for fulfilling the demands of the proposed research.

Mohr states that causality can best be established using a true experimental design, which is capable of establishing "how and why" the observed change was caused during the study with minimum threats to internal validity (Mohr, 1995).

However, experimental designs do not give an in context and in-depth view of "how and why" the change occurred, and hence may be weak on formative evaluation information.

Research strategy	Form of research question	Focuses on contemporary events?	Ability to establish causality?	Fulfil demands of literature?	Supports requirements of theoretical framework?
Experiment	how, why	yes	yes	yes	yes
Survey	who, what, where, how many, how much	yes	no	yes	yes
Archival analysis	who, what, where, how many, how much	yes/no	no	no	no
History	how, why	no	no	no	no
Case study	how, why	yes	yes/no	yes	yes

Figure 3-2: Research methods and their capabilities

(adapted from Yin 1994, and Mohr 1995)

The combination of literature demands together with Yin's and Mohr's taxonomies point to the selection of a multiple method design for conducting this research.

Given the "either/or" style of the debate on "the relative importance of media attributes versus instructional methods" (Jonassen et.al. 1994) in determining the effectiveness of an instructional programme this study intends to take a "both/and" approach to the issue. This is a systems approach that acknowledges the need to see the learning environment as a system with the instructional methods and delivery medium dependent on one another for overall impact on student learning. This approach however will require in-depth work to gain a "consummate understanding" (Mohr, 1996) of the causal learning process, from which selective generalisations can then be made.

So the research approach chosen is a multiple method design involving a case study approach. This case study approach incorporates experimental and survey work to enrich the in-depth understanding of the phenomenon under study and provide a sound foundation for causal inferences. This overall design can be seen in Figure 3-3 including the chapter structure of the remainder of this study.

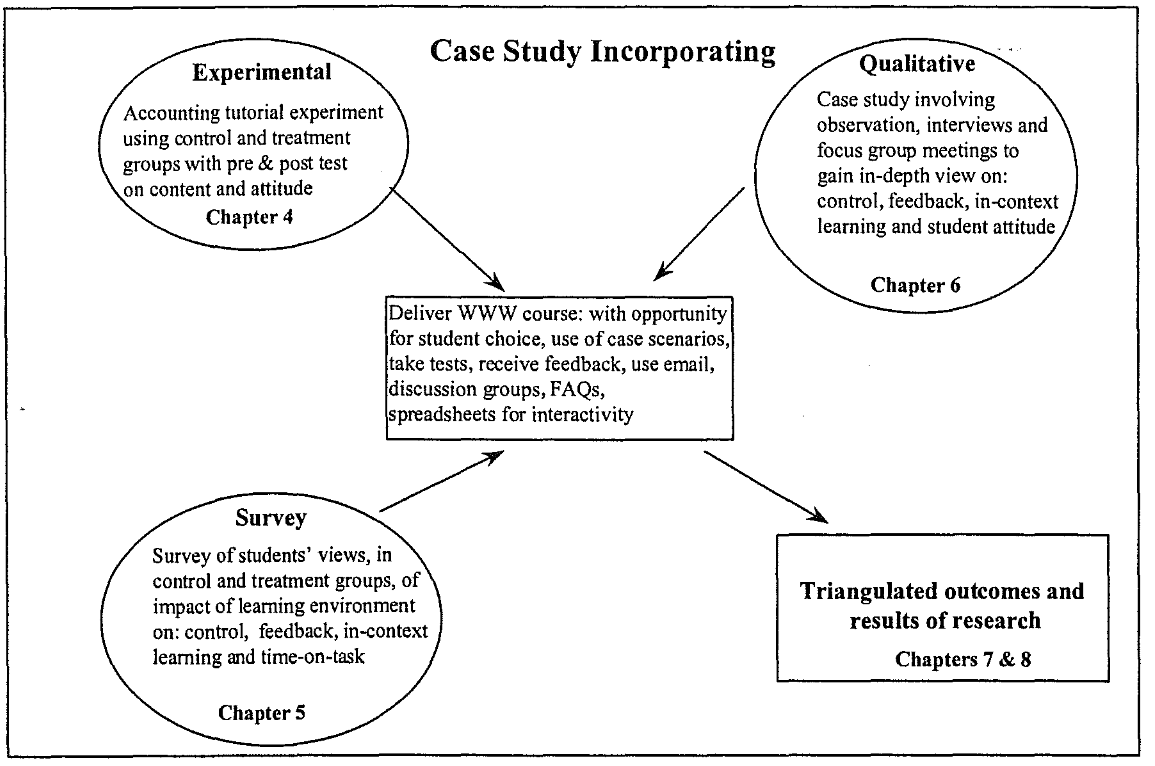

Figure 3-3: Overall research method

Assuring quality of research design

In judging the quality of a research design there are certain tests that may be applied that will assure the quality of the work at hand. There are four tests that are acknowledged as being most useful, and are widely used as the basis for determining quality of research in the Social Sciences (Yin, 1994, Campbell & Stanley, 1963, Traub, 1994, Chen 1990, and Mohr 1995). These four tests are:

- Measurement validity: setting up appropriate measures for the theoretical constructs under study
- Internal validity: demonstrating that the causal link between treatment and outcome is certain or strong
- External and Construct validity: delineating the basis and realm to which the research and its theoretical constructs can be generalised

- Reliability: establishing the ability to replicate the study

Measurement validity

The instruments used to collect data and the measures used for the theoretical constructs for this study are covered in the appropriate chapters: Chapter 4 for the experimental portion of the study, Chapter 5 for the survey portion of the study and Chapter 6 for the qualitative section.

Dealing with threats to internal validity

A key factor in asserting the conclusions drawn from any research with confidence is the issue of the validity of the research design. A weak design will raise many questions over the validity of the research outcomes even when there are strong results. A strong design on the other hand is its own sound research - even in the face of weak results. In dealing with issues of the strength of the design, both internal validity (demonstrating that the causal link between treatment and outcome is certain or strong) and external validity (ability to generalise the results to other settings) must be dealt with. Issues of internal validity are also sometimes referred to as Trustworthiness in the evaluation literature (Chen, 1990).

Threats to internal validity are those threats that would suggest that the research design employed leaves the causal link between treatment and outcome uncertain. Figure 3-4 describes the primary threats to internal validity as well as the steps taken in this research design to deal with those threats.

Threat	Strategy
Threat of history: unanticipated, uncontrolled change over time (external events, testing, maturation, regression and attrition)	Use of treatment and control groups for comparison. Use of pre-test to determine a clear starting point for both the control and treatment groups.
Threat of selection: selection bias in assigning subjects to treatment or	Randomisation of subjects and use of a pre-test/post-test design

control groups	
Threat of contamination: the potential that the control group will gain unauthorised access to the treatment	Students in the treatment group were given user ID/password to control access to the WWW tutorial material, as well as instructed not to let others use their account. In addition the control group students were told that they would have access to the WWW tutorial material after the experiment was complete.
Tutor bias: the problem created where some tutors are very good and others poor, and student performance is affected by this factor, thus confounding the results of the treatment	A given tutor took both face-to-face and WWW tutorials, thus mitigating this threat
Training effect: because the pre-test and post-test are the same students learn what the questions are and will naturally perform better the second time	Use of randomisation with the control and treatment groups means the effect should be equal across both groups. In addition a second version of the pre-test was created. The pre-test was given in two groups (two streams of students). Stream A received Version 1 and Stream B Version 2. In the post-test this was reversed. See Chapter 4, Figure 4-3 for further discussion on equivalence of the two versions.

Figure 3-4: Threats to internal validity

Dealing with threats to external validity

External and construct validity are both related to the issue of generalisability. External validity deals with generalisability to other settings, populations, times and places; while construct validity deals with generalisability to theoretical constructs due to the way in which the research design was operationalised. Dealing with threats to external validity will be covered in this section, while dealing with threats to construct validity will be covered in the following section.

Threats to external validity are those that raise doubt as to the ability to gain equivalent results under different circumstances of student population, time, place or disciplinary content. Threats to external validity have to do with the generalisability of the conclusions of the research. Figure 3-5 describes the primary threats to external validity as well as the steps taken in this research design to deal with those threats.

External validity can be established in two ways including:

- Statistical generalisation where the researcher generalises from a sample to a population, typically used in survey research.
- Analytical generalisation where the researcher generalises from a particular set of results to some theoretical construct, typically used in experimental and case study research.

This research will be using the analytical meaning of generalisability. An accepted limitation of this research is the need for replication of this work in multiple disciplines to verify the theory and extend the generalisability to a greater variety of settings. Given the formative nature of this research, the limitation is acceptable and can be overcome in future work.

Generalisable regarding	Strategy
Overall	The use of multiple research methods to gain both in-depth insight into the learning interactions, as well as experimental outcomes for creating strong causal inferences should allow a high level of generalisability to the theoretical constructs.
Student population: First year University, New Zealand students	Demographics on sex, age and ethnic mix will provide some insight into population characteristics. When considered with in-depth causal reasoning from experiment and case study, it should allow reasonable generalisation to other English speaking student populations of similar socio-economic circumstances.
Other times	The results from this study should be used cautiously when considering them too far in the future, given the rapidity of change in technology, culture and attitudes toward learning technology. No strategy.
Other places and settings	Future replication of modified design (based on formative outcomes of this research) in other places and settings.
Other disciplinary content	Future replication of modified design (based on formative outcomes of this research) in other disciplinary settings.

Figure 3-5: Threats to external validity

Dealing with threats to construct validity

Construct validity deals with generalisability of theoretical constructs due to the way in which the research design was operationalised (Chen, 1990, Mohr, 1995, Nunnally, 1978).

- Will a particular set of items on a survey (purporting to measure a certain concept) strongly correlate in a given setting?

- Will a different set of items on a different survey intending to measure the same concept strongly correlate with the first set of items on the first survey?

- Will a given survey or experimental design produce similar results in a different setting?

These are issues of construct validity. The following describes the various strategies used in this research to strengthen construct validity.

Strategies for strengthening construct validity

- Perform factor analysis on experimental survey items on attitude towards accounting and computing. Compute Kronbach's Alpha.

- As part of focus group session have students categorise best and worst features as control, feedback, and in-context learning.

- Conduct interviews covering the same types of questions as are covered in the learning survey.

- Carry out post intervention interviews with best and worst performers.

The above multiple sources of data provide convergence or triangulation thus providing multiple measures of the same phenomenon (Yin, 1994).

Dealing with reliability issues

Reliability issues deal with the likelihood of gaining the same results given the same setting. This is sometimes referred to as Objectivity (Chen, 1990) which might also include features of internal validity. This is fundamentally the issue of the ability to replicate the study and gain similar results. In case study research this is dealt with by using a case study protocol that is sufficiently detailed to allow another researcher to replicate the work. The next section of this chapter deals with the case study protocol for this research design.

Design of case study protocol and overall method

Having settled on using an overall case study research process involving multiple research methods it will be useful to design a case study protocol incorporating the various research methods.

This design is further informed by prior work in the field, conforming to Culture Four of Brigg's hierarchy of research paradigm's for educational technology, (see section entitled Impact of Technology on Higher Eduction, sub-section Research Paradigms, of Chapter 2)

This section lays out the framework for the case study and provides a background description of the procedures to be used in the full research design including qualitative, experimental and survey methods. The section includes:

- The Case Study Framework with: the Time frame of the case study, the Units of Analysis and the Criteria for interpreting the study's findings
- Overview description of research processes to be carried out
- Field procedures to be carried out

Appropriate sections of the detailed protocol are included with each of the appropriate chapters: Chapter 4 on Experimental work, Chapter 5 on Survey work and Chapter 6 on Qualitative work. The full case study protocol may be found in Appendix A.

Case study framework

Time frame of case study

This study was carried out in the context of a large, full year, introductory accounting course involving over 600 students. The course took place from early March 1998 to early October 1998. The total number of lecturing weeks was 25, broken into 4 terms of approximately 6 weeks. The course consisted of two hours of lectures per week, conducted in two large streams of more that 300, plus one hour of tutorials per week. Formal summative assessment consisted of a term test (30%), a practical computerised accounting test in a computer lab (5%), a written project (10%) and a final exam (55%).

The portion of the course that was the focus of this study was the double entry accounting portion, which occurred early in the course from mid-March to early April. The time frame for the conduct of the case study can be seen in Figure 3-6.

Dates	Description
6 Feb-13 March 1998	Test courseware and treatment group survey instrument on group of first year volunteers not taking AFIS 111 (from AFIS 123)
10 March 1998	Conduct pre-test during lecture times
11 March 1998	Train tutors in use of AFIS On-line system
16 March-3 April 1998	Conduct tutorials, observations and interviews
30 March-3 April 1998	Conduct learning survey during last tutorial of series
7 April 1998	Conduct post-test in lecture times
3 April 1998	Conduct focus group meetings
1 –10 February 1999	Conduct follow-up interviews

Figure 3-6: Time frame of case study and data collection

Units of analysis of case study

This study includes a primary unit of analysis, an accounting class, and three embedded units of analysis: individual tutorial groups, individual students and groups of tutorials (treatment group and control group). The focus of the study is effective learning, in this case the effective learning of double entry accounting, and thus naturally includes the individual students as well as the larger units: the tutorials and the full class. Given the experimental portion of the study the tutorials are divided into treatment and control group tutorials.

Criteria for interpreting the study's findings

The fundamental criteria for interpreting the study's findings will be the extent to which the findings support or contradict the research question, hypotheses and research model established at the beginning of this chapter. This theory driven approach will attempt to use the multiple sources of evidence to triangulate the results, strengthening the assertions made and recommendations for future work, in the light of the formative analysis.

Description of research processes to be carried out

The chosen multiple method research approach involves a number of processes that must be carried out to achieve the research goals. In addition to creating appropriate course content it was necessary to have the entire process reviewed and approved by the University of Canterbury Human Ethics Committee, which oversees all research involving human subjects. The form approved by the committee may be seen in Appendix B.

Processes required before conducting the research included appropriate liaison with the course supervisor and lecturers in the target first year accounting course. This liaison covered issues of content and logistics in this large course with over 600 students (with two streams, a morning lecture group and an afternoon lecture group). In addition the creation and validation of the necessary test and survey instruments was needed (covered in the following section).

Field procedures

The procedures to be carried out in implementing the research design and gathering data can be organised in line with the types of field work to be carried out. These include:

1. Experimental work (Chapter 4)

2. Survey work (Chapter 5)

3. Tutorial observations (Chapter 6)

4. Individual student interviews (Chapter 6)

5. Focus group meetings (Chapter 6)

6. Tutor email messages from students (Chapter 6)

7. Follow-up interviews with best and worst performers (Chapter 6)

The detailed protocol describing the procedures that were carried out and the questions that were addressed are included in the various analyses in Chapter 4 (experimental), Chapter 5 (survey) and Chapter 6 (qualitative). Also included in Chapter 4 is a description of the pre-test and post-test instruments that were used along with a description of their construction and validation. Similarly for Chapter 5 (Survey) a description of the survey instruments along with a description of their construction and validation. The full Case Study Protocol may also be seen as a unit in Appendix A.

Consideration of research design with theoretical model

The impact of the research design on the research model can be seen in Figure 3-7, with research design elements added to the research model in italics. The pre-test establishes the starting point of knowledge and attitude for determining the impact of the Web enabled course **activity** (the treatment). Classroom observation and interviews provide an in-depth understanding of the learning phenomenon in its real world context. The learning survey determines student perceptions of the impact of the learning environment on student learning for the three student **process** variables of control, feedback and in-context learning. In addition focus group meetings after the activity is complete provide a small group view on process variables. The post-test provides a measure of the impact of the treatment on student **engagement** as measured by the attitude variables, with the time-on-task information coming from the learning survey. Finally student learning, including deeper learning, is also captured on the post-test. Together these research components provide a sound foundation for making causal inferences about the learning environment.

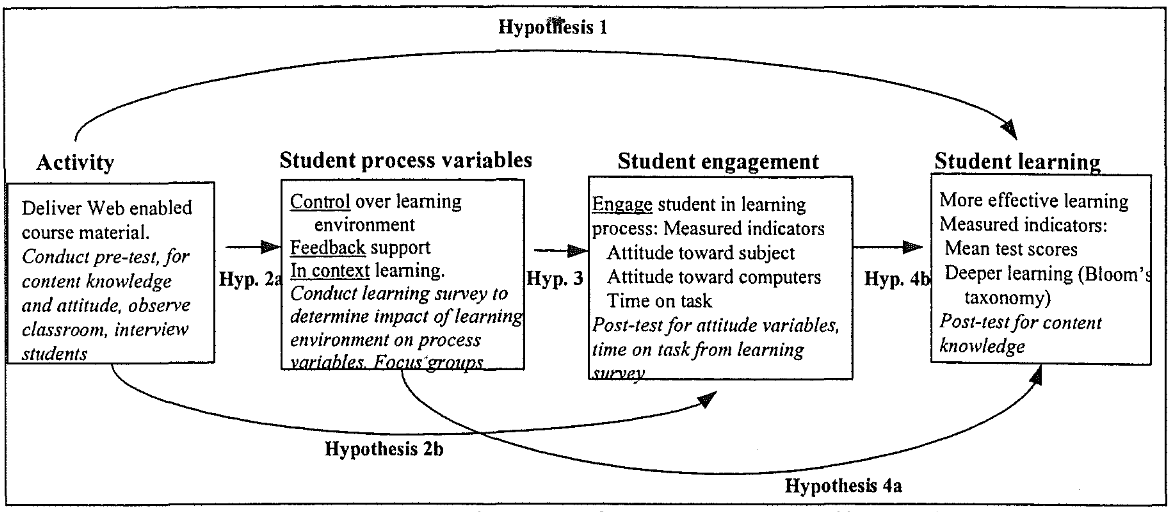

Figure 3-7: Research model and impact of research design (from Figure 3-1)

Outline of Data Analysis

The fundamental strategy for analysing the evidence gathered in the conduct of this study will be to consider the evidence in the context of the theoretical framework established by the research questions and hypotheses shown earlier in this chapter and the model shown in Figure 3-1. The analysis will discover the extent to which the various forms of evidence support or contradict the theoretical framework. Given the formative nature of the study, the evidence will be used to modify the construction of future web enabled courseware design, as well as strengthen the theoretical foundations of that design.

The plan for the analysis of the data can be found in Figure 3-8.

	Data description	Analysis process
1.	Pre-test/post-test experimental data: content knowledge, attitude towards content (accounting) and attitude towards computing. (Chapter 4)	Compute comparative descriptive statistics for control and treatment groups, including Bloom's Low and Bloom's High results Perform factor analysis on attitude data, compute Cronbach's alpha for reliability statistics. Perform impact analysis using regression. Compute effect size for comparison to prior experimental studies

2.	Learning survey data (Chapter 5)	Compute comparative descriptive statistics for control and treatment groups Rank order most valuable features of web learning environment (from survey responses) Create composite variables for impact analysis Perform impact analysis using regression
3.	Comments on open question from learning survey (Chapter 5)	Categorise comments as compliments or complaints
4.	Tutorial observations (Chapter 6)	Review observations to verify effective implementation of coursework design Review observations for reaction of treatment group to the learning environment, including any group interaction naturally arising in the lab environment and thereby add depth to understanding of the causal nature of the learning environment Review observations to discover any problems appearing in the use of the web enabled learning environment
5.	Individual student interviews (Chapter 6)	Compile student views as to what worked well and what did not work well in the web enabled learning environment. This will be used to validate observations and add depth to understanding of the causal nature of the learning environment. Analyse student responses with regard to student process variables of control, feedback and in-context learning to discover individual perceptions.
6.	Focus group meetings (Chapter 6)	Produce rank ordered list of best and worst features of the web enabled learning environment to provide formative

		data for the modification of future research and course-ware designs. Categorise best and worst features as control, feedback or in-context to provide additional data on use of these student process variables
7.	Tutor email messages from students (Chapter 6)	Categorise email comments as compliments on good features, complaints about bad features, request for help on content issues and requests for guidance on use of features of the learning environment.
8.	Follow up interviews with best and worst performers (Chapter 6)	Review interviewees' comments to discover their views 10 months after the intervention, especially to discover what other events were affecting their learning at the time of the intervention.
9.	Synthesise data: overall (Chapter 7)	Synthesise all qualitative and quantitative data to give a holistic view of results.

Figure 3-8: Plan for data analysis

In choosing a data analysis method for the quantitative data (items 6 and 7 in figure 3-8) the issue of using Structural Equation Modelling (SEM) versus regression was considered. In the end regression for impact analysis (see the next section for a description of Impact Analysis) was selected for the following reasons:

- Given the formative nature of this research, the learning survey was designed to discover students' views on the effect that the various web courseware components had on student learning. These survey questions were formative in nature in that they form the underlying latent process variables of control, feedback and in-context learning. SEM programs such as LISREL and EQS are designed to work with reflective items that reflect the underlying latent variables. This factor ruled out using SEM on the survey data (see Chin, 1998).

- The attitude survey items on the pre-test and post-test are reflective in nature, and so SEM could possibly have been used with them. However using SEM on experimental data is unusual, and the SEM analysis could not be carried through to the learning survey data, thus requiring the use of two different analysis methods on data that was intended to integrate.

- The existence of a considerable range of qualitative data means that multiple integrating viewpoints are present, reducing the need for the integrating data analysis that SEM brings.

Impact analysis

Impact analysis is fundamentally about establishing a causal chain of evidence when evaluating an intervention or research programme (Campbell & Stanley, 1963; Mohr 1995 and Chen 1990). Thus the purpose of impact analysis is to establish causal links from the treatment, through intervening variables (Chen, 1990) or sub-objectives (Mohr, 1995) through to the primary outcome under study. This form of analysis is to be contrasted with a typical approach to programme evaluation that simply looks at the effect of a treatment upon an outcome. This approach does not clearly demonstrate how or why the treatment affected the outcome under study, thus frustrating formative objectives that might allow such research to inform and guide future work. The impact analysis framework can be seen in application by reviewing Figure 3-1 that establishes the theoretical model for this research. Here we see the treatment (the activity of delivering web mediated course material) impacting the outcome of interest (more effective learning) through two linked sets of intervening variables or sub-objectives: (1) student process variables of control, feedback and in-context learning and (2) student engagements variables of attitude towards content, attitude towards computers and time-on-task.

The process of carrying out the quantitative portion of the impact analysis involves computing a series of regression equations that establishes if:

1. The treatment had an impact on the outcome of interest, and how strong that impact was.
2. The treatment had an impact on the intervening variables, and the strength of that impact.

3. The intervening variables had an impact on the outcome of interest, and the strength of that impact.

Through this series of regressions is established a causal chain, which demonstrates the impact of the various components of the model on its antecedents, thus strengthening the causal inferences that can be made.

Design of WWW enabled course

In order to carry out the intended research appropriate course content was required covering the fundamental double entry accounting process. A search was conducted to discover if such material for delivery through the medium of the Internet was available. Unfortunately appropriate material was not discovered, so with the assistance of a research grant from the University of Canterbury appropriate material was created using the TopClass on-line course management environment.

The course module chosen for development was the double-entry accounting concept. This was chosen because it presented a historical problem with the Introductory Accounting course: some students arrived at University with a couple years of accounting in high school, others arrived with no experience. This significant disparity between students meant that during the early part of the course the double-entry material went too fast for the inexperienced and too slow for the experienced, thus not really meeting the needs of either group. Workshops and special sessions helped with this, but it was an ongoing problem. It was felt by the course lecturers and supervisor that students who did pass the course and go on to further accounting studies often did not have a deep enough grasp of the concepts and impacts on the financial statements.

The course-ware was designed with the following key factors in mind:

- The student population would be dichotomous with some having a good basic knowledge of accounting and others with no knowledge. The system was designed to allow those with a higher level of knowledge to skim through the material, gaining feedback from the on-line tests to confirm their knowledge, and then moving on to other material. For those with little or no knowledge the system allows them to gain access to three levels of resources, depending on the level of their need: Hints on tests, Dictionary with examples, and Textbook references. In addition, resources include an interactive Excel spreadsheet for each episode.

- Interactive, to provide practical application of the knowledge learned and deeper learning
- Rapid feedback from on-line tests, for more accurate and deeper learning
- Case based, to provide the learning in-context
- Control over content and pace, to engage them more deeply in the learning process
- Fun, including audio clips of favourite music (at their choice) for background while studying. This feature, although created, was ultimately disabled due to the logistics problems in group laboratories and the need for headphones.

As can be seen in Figure 3-7 these are the characteristics being used to measure the impact of the learning environment by this research. These learning method characteristics were incorporated into the Web enabled module using various Web based technologies for delivery in an on-campus (Intranet) setting. The association matrix in Figure 3-9 shows the support given by each technology to the given learning methods:

Effective learning methods	Hyper-text	Helper apps: spread-sheet	Data-base of on-line tests	Email	Audio clips	Bulletin boards and discuss-ion groups
Interactive learning	X	X	X	X		X
Deep learning	X	X	X			X
Ability to apply knowledge		X	X			
Joy of learning				X	X	
Feedback and two way communication,		X	X	X		X
Problem & case based learning	X	X	X			
Learning in context	X	X	X			
Control over content & pace	X	X				

Figure 3-9: Table of learning methods and Web technologies

A further description of the implementation of the above design is given in the sub-sections below, including components or concepts that incorporate both the effective learning methods and the technology delivery in order to demonstrate some of the synergy of these elements.

- **Case based learning:** This learning module provided all of the basic instruction through a hypothetical case scenario the student must work in, responding to situations as they arise in the case. The scenario was one where the student is starting up and running their own business, and must do the accounting for it as well. Where the student was already familiar with the material they could move quickly through the case, responding accurately to the situations. Where students were unsure of how to proceed, hypertext links took them to increasing levels of explanation, examples and textbook references, to increase their understanding. The student was given an opportunity to choose the type of business they would be involved with in the case scenario (three choices were provided). The three scenarios covered identical content but the background (type of store, type of product etc.) differed.

- **On-line, interactive, tests and supporting resources:** For rapid feedback and in context learning on-line tests were created for student learning and feedback. There were three versions of each test, consisting of 10-14 multi-choice and other short answer questions. Each question was paired with a hint button, so that if the student is unsure of the material they could get some help immediately. The hint button provided them with a hint and was also the gateway to the dictionary, worked examples with explanations, file of frequently asked questions and ultimately to textbook references for the set text in the course. The tests were automatically marked, with immediate feedback to the student, including a short explanation of why their answer was wrong (if it was wrong). The student could then study further, and take the second and/or third version of the test.

- **Interactive games:** To remove the boredom, enhance the fun and give an opportunity for healthy competition and application of the material learned an interactive, multi-user game was developed. The game required the players (up to four) to select content related questions from a question bank, to "arm" themselves. The questions varied in point value and difficulty. The players then "fired" the questions at the selected "opponent", who gained points by answering correctly within a time limit, or half points if they requested a "hint". Class members all started at the same game level ("accounting clerk") and were promoted to higher levels as they "win" games. Learning took place in various ways: selecting questions presumed they knew the answers themselves, "hints" on questions they are unsure of, giving a wrong answer provided immediate feedback with the right answer. This feature was created, but ultimately disabled due to budget, performance and reliability problems. It was expected that this feature would have had an impact on outcomes, increasing the learning and attitude of students in the treatment group.

- **Interactive spreadsheet:** This consisted of a series of Excel spreadsheets accessed as a helper application from within the main hypertext/HTML document. The spreadsheet required the student to respond to increasingly difficult or deeper additional situations in the case scenario. The spreadsheets were set up to provide the student with immediate feedback on the types of errors in process or judgement.

- **Audio clips:** A number of MIDI audio clips were part of the system providing appropriate background music to certain sections of the case and activities. Students had control over volume and on/off controls and choice of music. This added another motivational/fun aspect to the learning environment for those who are aurally oriented in their learning. This feature, although created, was ultimately disabled due to the logistics problems in group laboratories and the need for headphones.

- **Bulletin board and discussion groups:** The opportunity to see the FAQs for the ongoing content of the instructional module and the answers put the student more in control of the educational process and also reduced the administrative workload for the lecturers involved. This also provided a venue for discussing course issues, along with the support provided by email and chat.

Outline of analysis chapters

Chapters four, five, six and seven report on the implementation of this research design and are arranged as described in Figure 3-3 and summarised below:

- ➢ Chapter four: Experimental analysis
- ➢ Chapter five: Survey analysis
- ➢ Chapter six: Qualitative analysis
- ➢ Chapter seven: Synthesis of results

In line with the research model and the above outline of analysis chapters, Figure 3-10 depicts the association of the research hypothesis with the research methods. This figure and Figure 3-1 will serve as a map for each of the subsequent analysis chapters.

Hypothesis	**Research Methods used**		
	Exper. Ch. 4	**Survey** Ch. 5	**Qualit.** Ch. 6
Primary:			
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	✓	✓	✓
Impact of web course on process variables			
2a (i). Support for higher student control		✓	✓
2a (ii). Support for improved feedback		✓	✓
2a (iii). Support for greater in-context learning		✓	✓
Impact of web course on engagement variables			
2b (i). Better attitude towards course content	✓	✓	✓
2b (ii). Better attitude towards computers	✓	✓	✓
2b (iii). Higher time-on-task		✓	
Impact of process variables on engagement variables			
3a. Process variables affecting better attitude towards course content		✓	
3b. Process variables affecting better attitude towards computers		✓	
3c. Process variables affecting higher time-on-task		✓	
Regarding effective learning			
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		✓	✓
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning	✓	✓	✓

Figure 3-10: Association of hypotheses with research methods

Summary

This chapter has described the purpose of this research study including the hypotheses to be tested and the formative nature of the study, with its focus on assessing the efficacy of Web based technologies to provide a pedagogically sound foundation on which to build more effective educational systems. The chapter has also laid out the research method to be used (a multi-method case study design) and the reasons for choosing this approach. Also covered were the aspects of the research design intended to assure the quality of the research in the context of validity and reliability.

The research processes to be carried out were described in general terms together with the data analysis plan, with the details being reserved for the analysis chapters: Chapter 4 (experimental), Chapter 5 (survey) and Chapter 6 (qualitative). Finally a description of the web enabled learning environment was provided.

The next chapter deals with the experimental portion of the study. As such it establishes a foundation for the quantitative portion of this study.

Introduction to Quantitative portion of study

The quantitative portion of this study consists of Chapters 4 and 5. Chapter 4 covers the Experimental portion and Chapter 5 the Survey portion. Between the two chapters the various components of the research model (see Figure 4-1) are tested using quantitative methods. The primary means of testing the model is through the use of impact analysis, using regression statistics. In both chapters the various hypotheses of the study are tested by equivalent regression equations (ie Hypothesis 1 is tested by Equation 1, Hypothesis 2a by Equation 2a, and so forth).

Chapter 4: Analysis of Experimental Data

Introduction and Overview

The experimental portion of this study provides a statistical foundation from which to reason regarding the fundamental outcome of this study – student learning. Does a web enabled learning environment provide a sound foundation from which students can learn more effectively? This core question is at the heart of this study, and the experimental component of this study permits fundamental insights into the answer. Of equal importance, a sound experimental design provides solid evidence in establishing links between the cause (a web enabled learning environment) and the hypothesised effect (better student learning) through intervening variables that answer the question "why" did the cause produce the effect. The intervening variables that will be assessed are student attitude towards the content area (accounting) and toward the learning environment (computing). Does student attitude towards accounting and toward the computing environment increase or decrease as a result of being in the treatment group? Further does this increase or decrease in attitude appear to affect their learning, positively or negatively, as measured on the pre-test and post-test of the experimental portion of this study? Although experimental results are capable of producing strong assertions regarding causality, given the exploratory and formative nature of this study the evidence generated will be treated as supporting or not supporting the given hypotheses, rather than demonstrating causality.

This chapter covers the design, data gathering and analysis of the experimental data from the research programme. The analysis will take place in the context of impact analysis, as described in Chapter 3, and will rely largely on regression analysis statistics in combination with the research model described in Figure 3-1, and reproduced below as Figure 4-1. Also included will be a discussion of "effect size" to anchor the current study into past work on Computer Assisted Instruction (CAI). Effect size "describes in standard deviations units the difference in performance of the experimental and control groups" (Kulik & Kulik, 1987). It is a concept used to permit comparison to prior research in the field, which has not been designed to establish a supporting link through intervening variables.

This chapter is organised as follows:

- Review of the research model and implications for experimental design
- The experimental design
- Factor analysis
- Descriptive statistics
- Impact analysis using regression statistics
- Comparison of effect size to prior studies
- Summary and conclusion

Review of research model and implications for experimental design

The research design developed in Chapter 3 provided a series of testable hypotheses, a research model to test them and a multi-method research process to operationalise the model. The research model can be seen in Figure 4-1 (from Figure 3-1) with the hypotheses to be tested by the experimental portion of the study (Hypotheses 1, 2b and 4b) in **bold.**

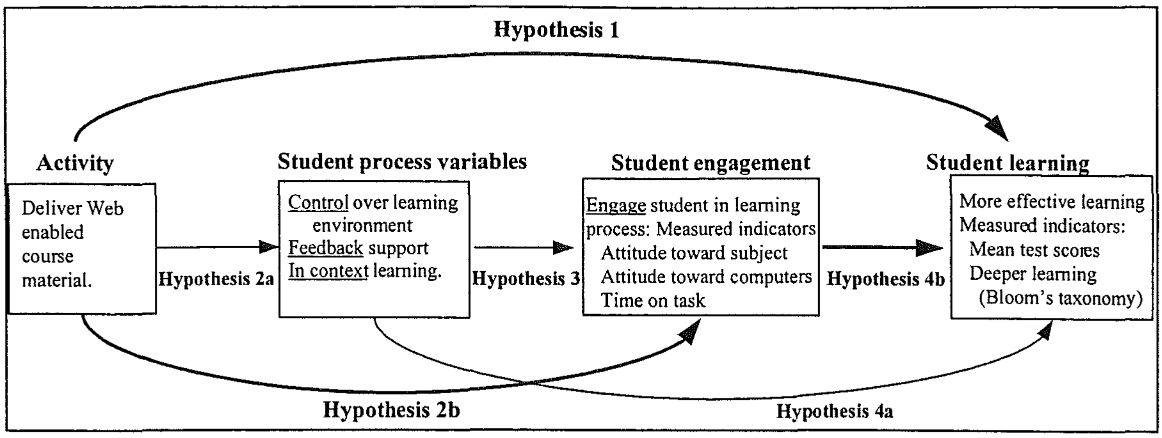

Figure 4-1: Research model (from Figure 3-1)

Figure 4-1 is supported by Figure 4-2, which lays out the testable hypotheses and the research methods that will supply evidence regarding those hypotheses (experimental support column shaded).

Hypothesis	**Research Methods used**		
	Exper. Ch. 4	**Survey** Ch. 5	**Qualit.** Ch. 6
Primary:			
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	✓	✓	✓
Impact of web course on process variables			
2a (i). Support for higher student control		✓	✓
2a (ii). Support for improved feedback		✓	✓
2a (iii). Support for greater in-context learning		✓	✓
Impact of web course on engagement variables			
2b (i). Better attitude towards course content	✓	✓	✓
2b (ii). Better attitude towards computers	✓	✓	✓
2b (iii). Higher time-on-task		✓	
Impact of process variables on engagement variables			
3a. Process variables affecting better attitude towards course content		✓	
3b. Process variables affecting better attitude towards computers		✓	
3c. Process variables affecting higher time-on-task		✓	
Regarding effective learning			
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		✓	✓
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning	✓	✓	✓

Figure 4-2: Association of hypotheses with research methods (from Figure 3-10)

Experimental design

Fundamental justification for using an experimental component in this study was established in Chapter 3 on research design. This section describes the details of the experimental design, including the objectives, procedures, instrument used and its validation.

Objectives

The objectives of the experimental component of this study include:

- To provide a strong foundation for the study, knowing that a good experimental design provides the strongest design for inference.
- To establish a supporting chain of evidence from which to support or refute the research hypotheses.
- To further enrich understanding of the learning phenomenon as a contemporary event in its rich, real world context.

Experimental procedures

The procedures used in carrying out the experimental component of this study were designed to minimise threats to validity and reliability and are covered in detail in Chapter 3 under the heading: Choice of Research Method-Assuring Quality of Research Design. These procedures include: use of treatment and control groups, randomisation of subjects, pre-test/post-test design, factor analysis, and computation of reliability statistics (Cronbach's alpha). These procedures are detailed below and in the following sections. Specific procedures included:

1. All students in the course self selected into 30 tutorial groups.

2. The concept of the research was described to all students in the two lecture streams, a handout sheet describing the process and asking for their participation was distributed at the same time (this sheet and the process having been approved by the University's Human Ethics Committee). Students were asked to complete the authorisation and return it to the researcher. This document may be seen in Appendix B.

3. The researcher then randomly chose 15 of the 30 tutorials to be the treatment group with the remaining 15 tutorials to be the control group, using the Eton Statistical and Math Tables, 4th edition, 1980 random number tables. Student movement was only permitted between like tutorials (treatment or control group tutorials) during the treatment period. Students in the treatment group

were given user IDs and passwords to control access to the web enabled learning environment during the treatment period. Of the 30 tutorials, attrition was such that two of the tutorials did not appear in the final data, leaving 28 tutorials for the data analysis.

4. Tutors were assigned to tutorial groups such that any given tutor would be tutoring some tutorials in both the treatment and control groups.

5. A pre-test was given to all students in the course (including both treatment and control groups) covering their accounting knowledge and attitude towards accounting and computing prior to the three week treatment. Two versions of the pre-test were created. One was used with the morning lecture stream and the other with the afternoon lecture stream. A sample of the pre-test may be seen in Appendix I-1. A further discussion on the construction and validation of this instrument is included in a following section of this chapter entitled Design of instrument and its validation.

6. The treatment group attended World Wide Web based accounting tutorials for three weeks, while the control group attended traditional face-to-face discussion tutorials.

7. Both groups continued attending traditional lectures as one larger group (in two lecture streams).

8. A post-test was given after the three week treatment period, reversing the order of the test versions given to the morning and afternoon lecture groups during the pre-test (see item 5 above).

Experimental questions

See Appendix I-1 for a copy of the pre-test which specifies the questions asked.

Design of instrument and its validation

The primary instrument to be used in the experimental component of this study is a pre-test/post-test. The following describes the instrument (see Appendix I-1) and its validation.

The pre-test/post-test contains sections for:

(a) identification data

(b) demographic data,

(c) information on the students accounting background and computing background/experience,

(d) 24 multiple choice content questions for the content area (Accounting), with 12 questions designed to test the lower portion of Bloom's taxonomy and 12 questions designed to test the higher portion of Bloom's taxonomy (see Figure 2-2),

(e) an eight item attitude survey regarding the content area and computers.

There were two versions of the pre-test prepared, one version was administered to the morning lecture group and the second version administered to the afternoon lecture group. The same two tests were used in the post-test, but reversing the order of delivery to the morning and afternoon groups. The pre-test and post-test were administered to the entire class, which included both those in the treatment group and the those in the control group.

The following process was used in validating the pre-test instrument, the details of which can be found in Appendix I-1:

Portion of Instru-ment	Validation process
Pre-test and Post-test content questions	Questions on the first draft were coded to Bloom's taxonomy dealing with deeper versus surface learning. A review of the first draft resulted in changing a number of the questions to provide a balanced number of questions from the lower half and higher half of the taxonomy (12 in each half). This constituted the second draft. The second draft pre-test was administered to three lecturers and two post-grad students for feedback on accuracy, suitability of the level of questions and readability. The issue of Bloom' High and Low coding was also reviewed with the

	course supervisor. This feedback was incorporated as a third draft pre-test. The third draft pre-test was used with a second year accounting course (AFIS 211). Feedback from this was incorporated into a final draft of the pre-test. The final draft was reviewed by the three lecturers involved in the course. Feedback from this review was incorporated, constituting the final pre-test. Creating the second version of the pre-test involved: (1) reordering the questions, (2) moving the correct answer to a different position and (3) some simple numeric replacements and word substitutions in questions. The identical number of questions was maintained as was the Bloom's level and level of difficulty of the questions. The two versions of the pre-test were administered as follows: Version 1 to Stream A of AFIS 111 (8am group) and Version 2 to Stream B (4-5pm). The post-test reversed the Versions and Streams. The use of a second version of the pre-test is intended to reduce any training affect between the pre-test and post-test and any change in difficulty between the two Versions of the test.
8 item attitude survey	This short survey was intended to provide data on the student's attitude towards learning accounting and toward computers as a learning tool to discover if that attitude changed as a result of their learning experience during the treatment period. This 8 item attitude survey section used all of the above validation processes that were used with the content portion of the pre-test. A search of ISWorld's survey instrument site produced no instrument related to attitude towards computers in a learning environment that was suitable. A search was also done of ABI-Inform, which indexes other business and computer periodicals. This search was also unsuccessful. In the light of this the 8 survey items were created by the researcher. Factor analysis was performed and Cronbach's alpha was computed to provide validation support for this instrument. This material is found in a subsequent section of this chapter.

Figure 4-3: Experimental instrument validation process

The pre-test/post-test results were processed for both descriptive statistics as well as in regression analysis to support impact analysis. These analyses are covered in subsequent sections of this chapter. However the immediate following sections first discuss prior work in measuring depth of learning including the use of multi choice test items to measure student cognition. This is followed by a related section on the use of the attitude variable and the items used to measure it in this instrument.

Measuring depth of learning

A number of the hypotheses of this study involve measuring depth of student learning. The concept of deep versus surface learning was discussed during the literature review in Chapter 2. Depth of learning has been measured in various ways, including comparisons between measurement methods. Methods have included:

- Student expression in essays assessed at levels of deep active, deep passive, surface active and surface passive. (Entwistle & Brennan, 1971

- Using qualitative methods: a combination of student responses on a survey in comparison to responses in interviews to determine depth of learning in a CAL module. These results were used to interpret student responses to open ended questions which required a structured response.. (McAlpine, 1996)

- A comparison of standardised mathematics testing to a problem based learning approach, showed that the two were both effective measures of student learning. (Fisher, 1996)

- An experiment in which student's were asked to think aloud as they solved a math achievement test, to determine student cognitive processes. Gierl (1997)

An additional widely used method for measuring depth of learning is the use of objective assessment. This method is used in the current study and is described further in the next section.

Higher order cognition and objective assessment

The current study uses multiple choice test items to measure student learning before and after the treatment period. The test items were constructed in line with Bloom's Taxonomy, to permit measuring depth of learning. The following section addresses how previous researchers have measured depth of learning and used Bloom's Taxonomy to assist with this process.

The use of objective tests, including multiple choice items, true/false and short answer questions are widely used, having benefits such as a more consistent result, lack of marker bias, ability to cover a wide range of material in a shorter time frame, and the ability to use automated marking methods providing rapid feedback to students and teachers. The research in this area indicate that multiple choice tests compare favourably with other forms of assessment including essay and problem solving questions (forms of performance based assessment). Often the best assessment provides a combination of these.

Lombard (1988) conducted a study comparing assessed writing proficiency of Grade 8 students who had English as their second language. An objective multiple choice test was compared with a subjective, essay test. End of year examination marks and final course report marks were compared with the multiple choice and essay test results. Statistical analysis of the four variables (objective test, subjective test, end of year examination and final course marks) indicated a significant correlation between the objective and subjective testing methods.

Because of some concern over the validity of standardised diagnostic (multiple choice) tests used to determine student preparedness for first year University calculus a study was conducted to compare the results of this test with a performance based assessment test. The qualitative and quantitative analysis carried out based on students' subsequent performance in algebra, calculus and chemistry found that the standardised diagnostic tests provided a better correlation than the performance based testing, but the combination of the two forms of testing provided the best predictor of math and chemistry achievement. (Fisher, 1996) A similar study involved the placement of tertiary students in appropriate English composition classes. The researchers studied the use of writing samples from students as a basis for placement instead of using SAT or ACT (standardised objective tests). The initial protocol for assessing the writing samples had to be modified due to grader inconsistency. This modification incorporated computer assisted processes to increase the reliability of the writing sample assessment. Even after modifying the protocol used to assess the writing samples, the researchers found that all but 7% of students entering the basic composition course would have been suitably placed by simply using the SAT or ACT (standardised objective testing) scores alone. (Alexander & Swartz, 1982). Multiple choice test items seem to provide an effective alternative to performance based assessment, a method designed to assess learning more deeply.

The demand for higher order thinking skills by employers has led to the development of testing instruments to measure these critical thinking skills. Sormunen and Chalupa (1994) discuss critical thinking as a higher order cognitive skill, one that can be taught, and one that can be measured. They go on to describe a range of the commercial tests that are available for assessment of critical thinking, most of which are multiple choice based tests. Usova (1997) supports this view:

> "The multiple choice format has also proven to be effective for testing higher cognitive thought processes. Carefully, well-designed multiple choice test items require candidates to think through responses and alternatives where they must weigh and consider the conditions posed in the stem of the questions and further discriminate and eliminate among plausible distractors before choosing the correct answer. The mental processes involved in arriving at the correct answer often challenge candidates to analyze and synthesize information in a problem solving context." (Usova, 1997)

Usova goes on to describe his use of Bloom's taxonomy in constructing new and modified test items for the Generic Fundamental Examination used to examine those seeking Reactor Operator or Senior Reactor Operator licenses in nuclear power plants nationwide in the USA.

Wu and Guei (2000) studied various forms of assessment and their ability to measure students' cognitive abilities. This study with Grade 6 students concluded that objective tests (multiple choice and short answer) were capable of measuring abstract relations and deductive reasoning as well as performance based assessment, a method specifically designed to assess deeper learning.

A study carried out by Norcini (1986) compared the assessment of physicians in clinical encounters through multiple methods. Methods used to assess performance included peer assessment, a computer simulation of the clinical encounter and a multiple choice test. The results of the study indicated that all methods were highly correlated and equally valid means of assessment.

Bloom's Taxonomy for measuring student learning

The use of Bloom's Taxonomy as a basis for measuring depth of learning finds its roots in Bloom's seminal work, *Taxonomy of Educational Objectives* (Bloom et al, 1956 and his continuing work in the educational evaluation arena with *Handbook on Formative and Summative Evaluation of Student Learning* (Bloom et al, 1971). The latter work provides guidance on the use of the Taxonomy for designing both formative and summative tests. This work has been widely used as a foundation for evaluating student learning across the six levels of the taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation. An overview of this material was covered in the early section of Chapter 2 entitled: "Models of Effective Learning: Bloom's Taxonomy".

Turning to the use of Bloom's taxonomy as a basis for creating multiple choice test items and evaluating a range of course work. A primary motivating force for the use of the taxonomy in constructing assessment is to avoid the problems associated with only assessing student learning at surface levels. A study conducted to categorise the questions found in reading skills development textbooks found that from a sample of 555 questions from 185 different text books, 545 questions fell into the knowledge and comprehension categories, the two lowest levels of Bloom's Taxonomy. (Hoeppel, 1980) This highlights the need for resources that will assess deeper levels of cognition. Studies done in tertiary Economics (Karns, 1983) and biology (Hoste, 1982) come to similar conclusions.

Cox and Clark (1998) provide a description of their use of multiple choice questions in formative quizzes assessing deeper levels of cognition. They used the RECAP model, an adaptation of Bloom's taxonomy using two divisions of the taxonomy. The RECAP model (Imrie, 1995) is formed by a lower division consisting of Recall: Comprehension and Application; and an upper division consisting of the top three levels of Bloom's taxonomy, but labelled Problem solving.. In teaching introductory computer programming, Cox and Clark had the aim of moving students through the lower levels of cognition and building on this understanding until students were able to apply their understanding to new domains and problem solving levels. They give examples of questions they used in determining students' learning at each of the RECAP levels of cognition.

Solman and Rosen (1986) support this division of Bloom's taxonomy into a higher and lower portion of the taxonomy, however they suggest that synthesis and evaluation should form the higher division, with the remaining four levels in the lower division. Gierl (1997) describes the assessment of mathematics learning using Bloom's Taxonomy as the basis for constructing assessment. The experiment involved student's thinking aloud as they solved problems on a mathematics achievement test. The students' cognitive processes were coded to discover if their processes matched the expected Bloom's cognitive level on the test question. The results of the study suggest that Bloom's Taxonomy does not provide an accurate model for anticipating the cognitive processes used by students. This experiment was conducted with Grade 7 students and only covered the lowest three levels of Bloom's Taxonomy. This may also suggest the division of Bloom's taxonomy into a higher and lower portion as being an appropriate division for differentiating learning outcomes.

Yunker (1999) describes her work in adding authenticity to summative assessment involving multiple-choice test items. The test items were constructed using two-way tables. Each table provided a matrix outlining the course content (measurement and psychology classes for pre-service teachers) along Bloom's taxonomy for levels of learning required for the content. Students were instructed when taking the test to select the BEST answer. The tests were then complemented with a process in which students were given the opportunity, after the test results were returned, to orally argue their perspective of BEST answer when the class reviewed the test results with the instructor. Thus students were able to challenge an answer result from the test by demonstrating their understanding of the content. The instructor reserved the right to make the final decision as to whether a "challenge" was successful or not. Yunker believes, based on historical data, that because of this process students are preparing more thoroughly for the tests and gaining a better and deeper understanding of the content. There is, however, no experimental data to support this.

The use of automated marking for multiple choice test items for formative assessment to diagnose areas of learning difficulty and to motivate student engagement can be seen in the educational technology arena. Brightman (1984) describes his use of computer based formative tests in a tertiary level business statistics course to provide feedback to students on the areas in which they are experiencing difficulty. Mehta and Schlecht (1998) describe the use of short quizzes at the end of a lecture to focus students' attention on the class material and discussion and provide quick feedback on student understanding. Their use of this technique in a large engineering class uses Bloom's Taxonomy in formulating the test questions and determining the depth of student learning as a result. They have migrated the process to a Web based interface and surveyed students for their opinions on the effectiveness of the process. 90 percent of students indicated that teaching and learning in this large engineering class was better when compared to other large classes they had taken. In addition students benefiting most from the process, based on the self report survey, appear to be those with lower grades (below 2.7 GPA), thus indicating those in most need are gaining the most.

Multiple choice test items have been used in a Web mediated environment, but of course not all usages of multiple choice items use Bloom's Taxonomy for creating these tests. A random assignment experiment in a large American Government course used Web quizzes, consisting of multiple choice questions, to determine if such formative testing had any effect on students' comprehension. The researchers found no significant difference on posttest scores between students who were assigned the Web quizzes and those who were not. (Class & Crothers, 2000) This research did not attempt to use Bloom's nor, any other, taxonomy to determine depth of learning, although they comment on their perception that most of the quiz items made no attempt to test higher level thinking skills. Although the researchers found no significant difference between those who used the Web quizzes and those who did not, there was a significant result when regressing the posttest result against the quiz results, controlling for the pretest.

Two studies conducted by Buchanan with psychology students (Buchanan, 2000) found that usage of a Web mediated formative assessment, consisting of multiple choice test items, did produce significant results in predicting student performance on the final exam. This study was practice based, not experimental, and thus the results must be taken as tentative. Nor did the researcher attempt to measure depth of learning from the quiz items used.

In summary, multiple choice test items are widely used to assess student learning, using both formative and summative assessment. The literature supports the usage of such tests as being comparable to performance based testing for assessing depth of learning, providing complimentary strengths for a more holistic assessment. The use of Bloom's Taxonomy for determining the cognitive skill level targeted by multiple choice items has also been widely used in a range of disciplines and educational levels. This process assists instructors in avoiding the pitfall of only assessing at the lower levels of the taxonomy by default . Furthermore, dividing Bloom's Taxonomy into higher and lower cognitive divisions has support, especially in a formative study such as this.

Content knowledge assessment is by its nature specific to a particular discipline and particular course within that discipline. No suitable test of accounting knowledge based on depth of learning was discovered in the literature to use in the current study. The current study thus uses Bloom's Taxonomy to construct 24 multiple choice test items to assess student learning prior to the treatment period and after the treatment period in a pre-test/post-test design. These 24 test items were constructed in line with two divisions of Bloom's Taxonomy: Blooms' Low and Bloom's High. The lower division incorporates questions targeted at knowledge, comprehension and application levels of the taxonomy, while the higher division incorporates questions targeted at analysis, synthesis and evaluation. The test items, categorised with the following legend can be seen in Appendix I-1:

> 1=Bloom's Low: K=Knowledge, C=Comprehension, Ap=Application
> 2=Bloom's High: An=Analysis, S=Synthesis, E=Evaluation

The next section covers the other major variable covered in the experimental portion of this study: student attitude.

Attitude measurement items

The current study measures student attitude toward computers (the treatment learning environment) and toward accounting (the instructional content area under study) as part of the pre-test and post-test experimental design. This section addresses how previous researchers have measured such items.

Attitude toward computing

A positive attitude toward learning technology can provide a support for student learning, while negative attitudes can present an obstacle to effective learning. DeLaughry (1993) suggests that up to one third of US students may be afflicted by a fear of computers. Such a negative attitude, may well have an impact on student learning in a computer mediated environment. Woodrow (1991) asserts that students' attitude toward computers is a critical issue where technology is used as a key part of the learning environment. Research into the impact of attitude on student learning is sometimes linked to self-efficacy, a measure of an individual's confidence in their ability to carry out specific behaviour and achieve a given outcome. (Zhang & Espinoza, 1998)

Woodrow (1991) assessed four computer attitude scales to compare their reliability and factorial validity. Also considered were the attitude dimensions and domains measured by the instruments. The four scales that were compared included:

1. The 30 item Computer Attitude Scale (Gressard and Loyd, 1986) including three sub-scales of Computer Anxiety, Computer Confidence and Computer Liking. This scale is one of the most widely used and tested instruments for measuring computer attitude, with all items formed as personal statements as advocated by Norris and Lundsen (1987) for attitude statements. Attitude dimensions covered included: anxiety, confidence and liking; all in affective and behavioural domains.

2. The 20 item Computer Use Questionnaire (Griswald, 1983). Attitude dimension covered was awareness, a cognitive domain.

3. The 10 item Attitudes Toward Computers (Reece & Gable, 1982). Attitude dimensions covered were broadly general and included cognitive, affective and behavioural domains.

4. The 11 item Attitude and Anxiety items of the Computer Survey (Stevens, 1980). Attitude dimensions covered were efficacy and anxiety in cognitive, affective and behavioural domains.

These four scales were joined into a single large survey with the items in random order and administered to a class of student teachers taking a computer course. The results of the study showed that all four scales provided a good measure of attitude, correlating well with each other (with the exception of the Computer Use Questionnaire), although measuring different attitude domains. Reliability levels (Cronbach's Alpha) were reasonably consistent and largely acceptable, ranging from .56 to .94. The Computer Attitude Scale at .94, its sub-scales of anxiety (.80), confidence (.86) and liking (.85) as well as the Attitudes Towards Computers (.87) had the highest reliability scores.

Montazemi and Wang (1995) used a 14 item instrument (Kernan and Howard, 1990) to measure student attitude toward computers in a tertiary Information Systems course. The computer based instruction system used a mastery learning approach. The attitude measurement instrument focused on the dimension of computer anxiety in the affective and behavioural domains, and Cronbach Alpha level of .94 was reported for the instrument in this study.

Zhang and Espinoza (1998) used the 19 attitude items from the Attitudes Toward Computer Technologies (ACT) by Delcourt and Kinzie (1993) as part of a larger instrument to measure the interaction between attitude, self efficacy and desirability of learning computing skills with tertiary students studying computing. The instrument focused on two dimensions of comfort/anxiety and usefulness in the affective and cognitive domains, reporting a Cronbach's alpha of .86 for the comfort/anxiety subscale and .82 for the usefulness subscale.

Crooks et al (1998) used a 10 item attitude instrument with a group of tertiary students in an educational psychology course to assess attitude toward computer based lessons and toward cooperative and individual computer-based learning methods and their impact on achievement. These items covered dimensions of computer liking, self efficacy and awareness in the affective, behavioural and cognitive domains. The reported Chronbach alpha for the instrument was .86.

In a study of adult basic education students taking a range of general education courses Massoud (1991) looked at the interaction between attitude toward computers and demographic variables of age, gender and level of computer knowledge. The attitude instrument used was the Computer Attitude Scale (Gressard & Loyd, 1986) described above in Woodrow (1991), covering dimensions of: anxiety, confidence and liking; in the affective and behavioural domains. The reported Chronbach alpha reliability coefficients were: computer anxiety sub-scale .78, computer confidence sub-scale .82, computer liking sub-scale .75 and total scale .91.

In summary the literature shows that a wide range of attitude scales have been used to measure attitude toward computers covering affective, behavioural and cognitive learning domains. Dimensions of attitude covered have included: computer anxiety, computer confidence, computer liking, computer self-efficacy, computer awareness, and computer usefulness. Measures of reliability of the instruments used have typically been reported in these studies. These alpha coefficients have been in the range of .56 to .94, with most above .75.

Attitude toward content area

As Woodrow also points out in measuring attitude, researchers have used a range of other scales to measure varying aspects of attitude. In a controlled study of tertiary accounting students (Abraham et al, 1987) use of computerised practice sets the researchers surveyed participants on their change of attitude toward accounting. The results of this study showed a significant improvement in student attitude toward accounting when compared to the control group that did not use the computerised practice sets. No measure of reliability was given for the attitude scale used. The attitude variable was measured with two questions:

1. Has your attitude towards accounting changed since you started this course?

2. If your answer to the previous question was yes, how has your attitude towards accounting changed? a. from like to dislike, b. from indifference to dislike, c. from like to indifference, d. from dislike to indifference, e. from indifference to like, and f. from dislike to like

Daroca et al (1994) conducted a study comparing the performance and attitude change of students in traditional lectures versus self-study classes for Managerial Accounting. The four item survey was administered before and after the course and requested information regarding the students' attitude toward accounting and business. No reliability coefficients were reported for this scale. This measure of attitude dealt with student attitude toward accounting, rather than toward computers. The four items on the scale were:

1. I feel that the things I will learn in this course will be useful to me in my professional career.
2. I feel that accounting is a very interesting subject.
3. I believe that the role of accounting information in helping people make decisions is relatively insignificant.
4. I believe that accountants are much more interested in details than in issues.

Research on attitude toward accounting has also been reported, although in a less rigorous fashion, with no measure of reliability being reported.

The current study used an 8 item attitude survey (see the end of Appendix I-1), 4 items on computer attitude and four items on accounting attitude. These items were all framed as personal statements, as advocated by Norris and Lundsen (1987) for attitude statements. The dimensions of attitude, for both accounting and computers, covered by the items included: interest, confidence, liking and importance for career. The Cronbach's Alpha reliability coefficient for the eight item scale was .78. The four computer attitude items are quite similar to questions covered in the Computer Attitude Scale by Gressard and Loyd, (1986) and had a Cronbach Alpha of .75. The four accounting attitude items are similar to the items used by Daroca et al (1994) and had a Cronbach Alpha of .72.

Summary of variable measurement for this study

The experimental portion of this study measures student learning, including depth of learning, together with attitude toward computers and attitude toward accounting. The previous section described how depth of learning and attitude have been measured in prior studies and how the current study has measured these variables. Details on the attitude variables showing the factor analysis and reliability coefficients are reported in the next section, followed by the outcomes of the depth of learning measurement of student learning.

Factor analysis of attitude survey

This section deals with the eight item attitude survey that was at the end of the pre-test and post-test (see Appendix I-1). The Cronbach's Alpha was computed to determine the internal reliability of the eight item survey used. Using the correlation matrix for the full student data on the post-test results produced a Cronbach's Alpha of 0.782. Given the small number of items in the survey this is a reasonably strong result (Nunnally, 1978; Lampe, 1999). Descriptive statistics for the eight items on the survey can be seen in Appendix I-2.

In carrying out the factor analysis a review of the correlation coefficient matrix and Cronbach's alpha was done on the post-test tutorial based data (unit of analysis) prior to carrying out the confirmatory factor analysis. Figure 4-4a presents these results, which indicate that item Atd4 correlates poorly with the other accounting attitude items. Similarly item Atd6 does not correlate very well with the other computing attitude items. These two items dealt with students' attitudes regarding learning accounting (Atd4) and its importance for career and students' attitudes regarding learning computing (Atd4) and its importance for career. Based on this evidence it was decided to omit these two items from the attitude factors in the following confirmatory factor analysis.

Accounting Attitude				
Cronbach's alpha=0.723	Atd1	Atd3	Atd4	Atd7
Atd1	1.000			
Atd3	0.831	1.000		
Atd4	0.100	0.145	1.000	
Atd7	0.536	0.491	0.265	1.000
Computer attitude				
Cronbach's alpha=0.749	Atd2	Atd5	Atd6	Atd8
Atd2	1.000			
Atd5	0.592	1.000		
Atd6	0.292	0.329	1.000	
Atd8	0.557	0.391	0.403	1.000

Figure 4-4a: Correlation matrix on all attitude survey items

A correlation matrix and Cronbach's alpha was run for the remaining attitude variables. The results of this can be seen in Figure 4-4b. The change to the accounting attitude items produced a significantly improved Cronbach's alpha, rising from 0.723 to 0.830. There was only a small improvement in the Cronbach's alpha for the computing attitude items however, from 0.749 to 0.760. Given the small number of items in the survey overall, these Cronbach alpha results represent a good level of reliability, and are sufficient to proceed with the confirmatory factor analysis.

Accounting Attitude			
Cronbach's alpha=0.830	Atd1	Atd3	Atd7
Atd1	1.000		
Atd3	0.831	1.000	
Atd7	0.536	0.491	1.000
Computer attitude			
Cronbach's alpha=0.760	Atd2	Atd5	Atd8
Atd2	1.000		
Atd5	0.592	1.000	
Atd8	0.557	0.391	1.000

Figure 4-4b: Correllation matrix on reduced attitude survey items

In carrying out the factor analysis a confirmatory factor analysis approach was taken, using the SEM (structural equation modelling) package EQS to statistically test the fit of the proposed factor model. The model tested was the two factor model incorporating Accounting Attitude and Computer Attitude with three indicators for each factor (as noted in Figure 4-4b) and run on the data for the 28 tutorial groups. The results of the confirmatory factor analysis, using a Maximum Likelihood solution, are seen in Figure 4-4c.

Description	**Null Model**	**Hypothesised Model**
Degrees of freedom	15	8
Chi-Square	78.161	12.992
P-Value for Chi-Square		0.111
Comparative Fit Index		0.921

Figure 4-4c: Goodness of fit summary for confirmatory factor analysis

The null model assumes that the model variables are uncorrelated, thus increasing the degrees of freedom. The null model was estimated and tested in EQS because in small samples it may fit as well as the hypothesised model, and if it does it raises serious questions about the explanatory ability of the model under consideration (Bentler, 1995b). The model under consideration must be considered in this light because of the small number of tutorials (28).

The Chi-Square statistic measures the degree of disagreement between the hypothesised model and the data (McClave, 1997). The fact that the Chi-Square for the null model is relatively large and the Chi-Square for the hypothesised model is significantly smaller provides evidence that the hypothesised model fits the data much better alleviating the concern regarding the small sample size.

The P-value for the Chi-Square statistic provides evidence that the model is outside of the rejection range, being greater than 0.05. Further the Bentler Comparative Fit Index (CFI) is reported. This practical index of fit was designed to deal with the problem of previous indices of fit which had a tendency to underestimate fit in small sample sizes (Byrne, 1994; Bentler, 1990). Given this study's small sample size it is a good choice as a fit index. The index ranges from zero to 1.00 and values greater than 0.90 reflect an acceptable fit to the data (Byrne, 1994; Bentler, 1992). The CFI for this model is 0.921, thus indicating a well fitting factor model and confirming this model as acceptable. Further analysis will proceed using this factor model, on the weight of this evidence.

The impact analysis in the following section will be run using composite variables based on the above factor analysis. The reason for the use of composite variables is again to minimise the impact of the small sample size in the use of regression analysis. Placing too many variables in the multiple regression equation would raise questions about the reliability of the results given the small sample size. The construction of the composite variables (Bentler & Chu) was accomplished by summing the values of the constituent variables. This was considered to be a satisfactory process as all variables were based on a six point Likert scale (a copy of the Pre-test with the survey at the end can be found in Appendix I-1) and there are three items in each of the composite variables. Construction of the composite variable can be seen in Figure 4-5 and their values can be seen in the descriptive statistics of the next section (see Figure 4-8).

Composite Variable Name and Description (see Appendix I-1 for original questions)	Name of original variables included in composite		
PreAtdA: Pretest attitude questions dealing with accounting	PreAtd1	PreAtd3	PreAtd7
PosAtdA: Post-test attitude questions dealing with accounting	PosAtd1	PosAtd3	PosAtd7
PreAtdC: Pretest attitude questions dealing with computing	PreAtd2	PreAtd5	PreAtd8
PosAtdC: Post-test attitude questions dealing with computing	PosAtd2	PosAtd5	PosAtd8

Figure 4-5: Composite variables and their component questions

The following section provides descriptive statistics for the experimental data including participation rates, demographics, composite variable values and analysis of demographic results against test scores.

Descriptive statistics

This section provides a range of descriptive statistics dealing with the experimental data for this study. Included are: student participation rates in the study, followed by demographics and overall means for the control and treatment group results. This set of tables provides an overview of the data.

Participation rates

The levels of participation from the AFIS 111, introductory Accounting and Finance course, can be seen in Figure 4-6, including attrition due to particular students not completing all components of the research design: consent, pre-test, survey and post-test. Some additional attrition occurred as a result of significantly incomplete portions of the data for some students.

Description	All	Treatment Group	Control Group
Official course roll	687		
Consenting to participate in the research	500		
Completing a pre-test		192	220
Completing a survey		210	196
Completing a post-test		202	237
Complete data set: consent, pre-test, survey and post-test		98	103
Complete data set: reduced for missing data on survey component		75	84

Figure 4-6: Student participation rates in the research

Demographics and overall means

Demographics from the pre-test data can be seen in Figure 4-7a.

Description	Control Group Pre-test	Treatment Group Pre-test
Age: 1=17-19; 2=20-25; 3=26-35; 4=36 & over	1.38	1.40
Sex:	m=44; f=40	m=43; f=32
Ethnicity: e=european; a=asian; o=other	e=54; a=22; o=8	e=49; a=19; o=7
Prior accounting: n=none; 5=5th form; 6=6th form; 7=7th form	n=36; 5=4; 6=9; 7=35	n=34; 5=3; 6=6; 7=32
Prior computing experience: 1=none…4=very experienced	2.43	2.57

Figure 4-7a: Pre-test demographics

The randomisation process for assignment of students to treatment and control groups appears to have worked quite well based on the demographic distribution with only small differences between the two groups in terms of age, sex, ethnicity, prior accounting and prior computing. In spite of this there was a difference between the two groups as to the pre-test results (Figure 4-7b), with the control group showing a 69.0% mean with the treatment group at a lower 66.2%. By comparison both groups learned a significant amount, moving up to 76.1% for the control group and 78.7% for the treatment group. From this we see that the treatment group rose 12.5 percentage points while the control group only rose 7.1 percentage points. This is mirrored by the performance of the two groups when considering the results divided into the Bloom's Low and High results, with the control group rising 9.2 percentage points and 5.1 percentage points respectively, while the treatment group rose 15.4 percentage points and 9.8 percentage points respectively.

Description	Control Group Pre-test	Treatment Group Pre-test	Control Group Post-test	Treatment Group Post-test
Overall	69.0%	66.2%	76.1%	78.7%
Bloom's Low	72.1%	67.7%	81.3%	83.1%
Bloom's High	65.9%	64.6%	71.0%	74.4%

Figure 4-7b: Comparison of means on pre-test/ post-test
(expressed as a percentage of the questions in the given category)

Attitude survey composite variable values and means

The descriptive statistics for the attitude survey composite variables (see earlier section of this chapter on "Factor Analysis of Attitude Survey") including the composite variable mean of tutorial group results and the mean of the contributing items may be seen in Figure 4-8. Descriptive statistics for the individual items that make up these composites may be found in Appendix I-2.

	Control Group		Treatment Group	
Composite Variable Name and Description (see Appendix I-1 for original questions)	**Composite mean**	**Mean of contributing items**	**Composite mean**	**Mean of contributing items**
PreAtdA: Pretest attitude questions dealing with accounting	11.18	3.73	11.29	3.76
PosAtdA: Post-test attitude questions dealing with accounting	11.05	3.68	11.70	3.90
PreAtdC: Pretest attitude questions dealing with computing	12.90	4.30	13.50	4.50
PosAtdC: Post-test attitude questions dealing with computing	12.56	4.19	13.38	4.46

Figure 4-8: Attitude survey composite variable means

With regard to accounting attitude the control group attitude deteriorated from the pre-test to the post-test by 0.13 (on the composite mean) while the treatment group mean rose by 0.41. This seems to indicate a considerable difference in response to the group learning environment, in favour of the web enabled learning environment of the treatment group. In the case of the computing attitude however both the control group and treatment group results went down with the control group falling by 0.34 and the treatment group by 0.12. Whether these results are significant or not will be addressed in the next major section of this chapter under the heading of "Impact analysis using regression statistics".

Although it is most common to use a significance level of 0.05 (5%) as the cutoff for a significant result, a number of results at the 0.10 (10%) level have been commented on in the following sections. This is due to the exploratory and formative nature of this study and the importance of avoiding Type 2 errors, that of accepting the null hypothesis, when attempting to discover important influencing factors in an exploratory study. While this will cause results of the study to be a bit more tentative, it will also mean that emerging learning factors will not be overlooked.

Analysis of demographic results against post-test results

Both simple regression (SRA) and multiple regression analysis (MRA) were run on the demographic data to maximise the insight into the student population. The regression analysis was run on the full student data file (159 records) to determine if any of the demographic variables had significant results against the test scores. The regression equations had the post-test results as the dependent variable, the various demographics as the independent variable(s) and the pre-test results as a control variable.

The SRA results are shown in Figure 4-9a. Sex and prior computing were not significant at the 10% level overall, and for Bloom's Low and Bloom's High. Age however was significant on Bloom's High at the 10% level with a negative coefficient. This indicates that on deeper learning as measured by the Bloom's High questions older students did more poorly.

Ethnicity was significant at the 10% level on Bloom's High with a negative coefficient. This indicates that on deeper learning as measured by the Bloom's High questions that ethnic minorities (Asian and Maori primarily) did worse than Europeans. There is a possibility that this is in part due to the second language effect for the ethnic minority students.

Students with more previous accounting showed the most significant results on post-test scores when controlling for pre-test results at a 1% significance level. This indicates that having had prior accounting did have a positive affect on deeper learning.

Description	Overall ($R^2 = 0.52$)			Bloom's Low ($R^2 = 0.58$)			Bloom's High ($R^2 = 0.23$)		
	Coef.	P-val	Signif	Coef.	P-val	Signif	Coef.	P-val	Signif
Sex	-0.007	0.624	N.S.	0.008	.650	N.S.	-0.021	.272	N.S.
Age	-0.007	0.516	N.S.	0.003	.828	N.S.	-0.024	.070	10%
Ethnicity	-0.015	0.121	N.S.	-0.018	.101	N.S.	-0.023	.055	10%
Prior computing experience	0.004	0.700	N.S.	0.009	.437	N.S.	0.002	.899	N.S.
Prior accounting	0.005	0.109	N.S.	0.004	.260	N.S.	0.009	.008	1%

Figure 4-9a: Simple regression results of pre-test/ post-test scores against demographics
(R^2 values were very close for all demographic variables, so a mean of the R^2 is shown)

These results were further analysed by running an MRA, the results of this can be seen in Figure 4-9b. This analysis shed further light on the backgrounds of the students and clarified the earlier simple regressions. The primary outcome of the MRA is to indicate that ethnicity and age both demonstrated some multi-collinearity with prior accounting. Older students and ethnic minorities are both much less likely to have taken prior accounting studies. This was confirmed by regressing age and ethnicity against prior accounting producing a significant result at the 1% level for both variables. The effect of this is to produce a non-significant result for ethnicity and age in the MRA, with a large reduction from the SRA results, and a corresponding reduction in the effect of the prior accounting to a significance level of 5%.

Description	Overall ($R^2 = 0.54$)			Bloom's Low ($R^2 = 0.60$)			Bloom's High ($R^2 = 0.27$)		
	Coef.	P-val	Signif	Coef.	P-val	Signif	Coef.	P-val	Signif
Sex	-0.006	0.698	N.S.	0.011	0.527	N.S.	-0.021	0.212	N.S.
Age	-0.001	0.939	N.S.	0.010	0.443	N.S.	-0.013	0.337	N.S.
Ethnicity	-0.013	0.200	N.S.	-0.018	0.118	N.S.	-0.016	0.212	N.S.
Prior computing experience	0.001	0.905	N.S.	0.005	0.711	N.S.	-0.001	0.911	N.S.
Prior accounting	0.004	0.156	N.S.	0.004	0.302	N.S.	0.007	0.032	5%

Figure 4-9b: Multiple regression results of pre-test/ post-test scores against demographics

The next section covers the impact analysis for the study hypotheses including providing a supporting chain of evidence regarding those hypotheses.

Impact analysis using regression statistics

Impact analysis, when used in a formative way, provides evidence regarding the impact of the treatment in two areas. Firstly as to the extent that the treatment did or did not have an impact on the outcome of interest, in this case student learning. Secondly as to the reasons <u>why</u> the treatment had the impact that it did. Also refer to the section entitled Impact Analysis in the later part of Chapter 3 for further background. The full impact analysis is covered in this chapter and Chapter 5. This section is organised as follows:

- Explanation of the regression equations used, in line with the research model and hypotheses
- Consideration of the results of the individual equations/hypothesis
- Consideration of the impact analysis through the supporting chain of equations showing the interaction of the hypotheses

The experimental portion in this chapter deals with three regression equations, while the remaining analysis is covered in Chapter 5. The results of these three equations, when considered together yield the impact analysis from the experiment. These three equations, representing the equivalent numbered hypotheses, are mapped on to the research model in Figure 4-10 for ease of understanding, and consist of:

Equation 1. The direct impact of the treatment (T, the activity) on student learning (Y) controlling for initial pre-test results (X)

$Y=\alpha^* + \beta_T^*T + \beta_X X + e_Y^*$

Equation 2b. The direct impact of the treatment (T, the activity) on student engagement (S_E, via the measured attitude factors), controlling for the student pre-test response on that same attitude factor

$S_E = \alpha' + \beta_T' T + \beta_{SE}' S_E' + e_{SE}$

Equation 4b. The impact of student engagement (S_E, via the measured attitude factors) on student learning (Y), controlling for pre-test results (X) plus the additional impact of the treatment (T, the activity) on student learning

$Y=\alpha + \beta_{SE} S_E + \beta_X X + \beta_T T + e_Y$

β_T^* represents the overall impact and is equal to the sum of β_T (the direct effect) and the product of β_T' and β_{SE} (the indirect effect) (Mohr, 1995).

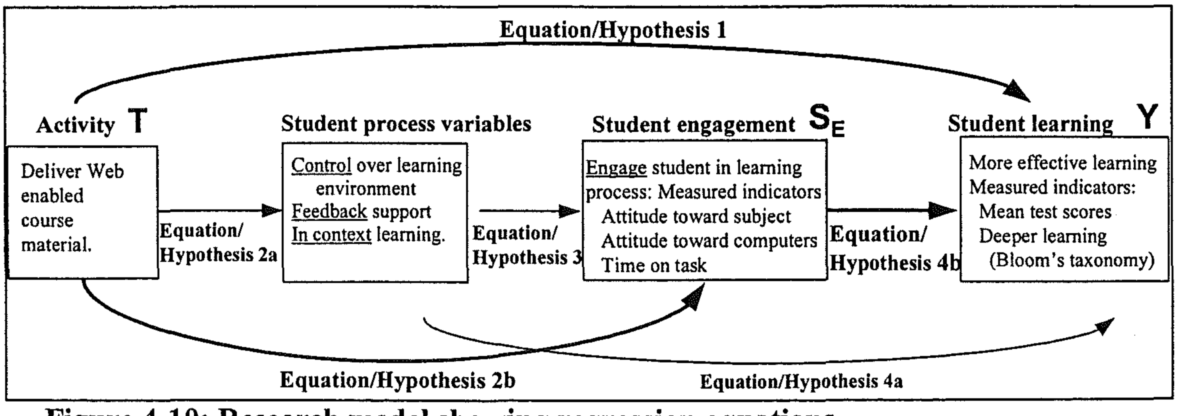

Figure 4-10: Research model showing regression equations

Regression analysis on experimental data

The unit of analysis in this section is the tutorial groups as randomly assigned to either the control or treatment groups, incorporating the average scores of the 28 tutorial groups (see the section entitled Quality of Research Design in Chapter 3, Research Design for further discussion on this).

Figures 4-11a, 4-11b and 4-11c summarise the results for the regressions carried out using the three equations and factor analysis results described in the previous sections. The results show the impact of the treatment (T) on content learning (Y), through the intervening engagement variables (S_E or sub-objectives) of attitude towards accounting (PosAtdA) and attitude towards computing (PosAtdC). This can be seen in the context of the research model and hypotheses in Figure 4-10 above and Figure 4-2 earlier in the chapter. A positive coefficient in Figures 4-11a, 4-11b and 4-11c indicates that the results are better for the treatment group than the control group, a negative coefficient indicates that the results are worse for the treatment group than the control group. The analysis shows the impact on the overall performance (PosScor), performance on the Bloom's Low section (PosBlmLo) and performance on the Bloom's High section (PosBlmHi) of the pre-test and post-test.

The results from Figure 4-11a, 4-11b and 4-11c can best be read by viewing the significance column (Signif) for whether the results are statistically significant (based on the P-Val) together with the coefficient (coef) column which shows the direction of the result (positive or negative).

Results regarding hypothesis 1: Impact of treatment on student learning

The results of Equation 1, in Figure 4-11a, show that being in the treatment group had a positive impact on student learning, significant at the 5% level on the overall post-test results. The equation was also run on The Bloom's Low and Bloom's High portions of the post-test data as separate dependent variables. For the Bloom's Low portion the results are also significant, at the 10% level, with the Bloom's High results being positive but yielding a non-significant (N.S.) result.

This can be seen further in looking at the coefficient for the overall score of 0.043 on β_T*. This indicates that those in the treatment group scored 4.3% higher on the post-test, when controlling for pre-test results than did the control group. This is approximately 1/2 grade higher. The proportional improvement is similar for Bloom's Low and for Bloom's High.

	Dependent Variable											
	DV: Overall Score; Y = PosScor R^2= 0.376, P-Val= 0.003				**DV: Bloom's Low Score; Y=PosBlmLo** R^2= 0.459, P-Val=0.000				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.206, P-Val=0.056			
Independent Variables	Coef	t	P-Val	Signif	Coef	t	P-Val	Signif	Coef	t	P-Val	Signif
β_T*=Category	0.043	2.061	0.049	5%	0.041	1.951	0.062	10%	0.039	1.508	0.144	N.S.
β_X=PreScor	0.608	3.669	0.001									
β_X=PreBlmLo					0.534	4.518	0.000					
β_X=PreBlmHi									0.436	2.185	0.038	

Figure 4-11a: Equation/hypothesis 1, impact of treatment on student learning (T $\rightarrow$ Y relation in Figure 4-12); $Y=\alpha^* + \beta_T{}^*T + \beta_X X + e_Y{}^*$

Results regarding hypothesis 2b: Impact of treatment on attitude

The results of Equation/hypotheses 2b(i) and 2b(ii), seen in Figure 4-11b, show that being in the treatment group had a positive impact on student accounting attitude, significant at the 10% level on the overall test results. However the results on the computing attitude were non-significant.

	Dependent Variable							
	Equation/hypothesis 2b(i) **DV: Accounting Attitude** **S_E =PosAtdA** R^2 = 0.512, P-Val= 0.000				**Equation/hypothesis 2b(ii)** **DV: Computing Attitude** **S_E = (PosAtdC);** R^2= 0.400, P-Val=0.002			
Independent Variables	Coef	T	P-Val	Signif	Coef	t	P-Val	Signif
β_T' =Category	0.574	1.755	0.092	10%	0.470	1.120	0.273	N.S.
β_{SE}' =PreAtdA	0.741	4.713	0.000					
β_{SE}' =PreAtdC					0.579	2.542	0.002	

Figure 4-11b: Equation/hypothesis 2b, impact of treatment on attitude
($T \rightarrow S_E$ relation in Figure 4-12); $S_E = \alpha' + \beta_T' T + \beta_{SE}' S_E' + e_{SE}$

Results regarding hypothesis 4b: Impact of student engagement on student learning

The results of Equation 4b, in Figure 4-11c, show that a more positive attitude towards accounting had a very strong positive impact on student learning, significant at the 1% level on the overall test results. The Bloom's Low and Bloom's High results are also significant, at the 1% level. However Equation 4b for the computing attitude produced a non-significant negative result on student learning, similar to the result of Equation 2b(ii) for this variable (see Figure 4-11b).

	Dependent Variable											
Accounting Attitude	**DV: Overall Score; Y=PosScor** R^2= 0.625, P-Val= 0.000				**DV: Bloom's Low Score Y=PosBlmLo** R^2= 0.669, P-Val=0.000				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.428, P-Val=0.003			
Independent Variables	Coef	t	P-Val	Signif	Coef	T	P-Val	Signif	Coef	T	P-Val	Signif
β_{SE} = PosAtdA	0.029	3.994	0.000	1%	0.030	3.900	0.000	1%	0.031	3.054	0.005	1%
β_T=Category	0.022	1.244	0.225		0.015	0.836	0.411		0.020	0.855	0.401	
β_X =Pretest	0.525	3.953	0.000		0.396	3.923	0.000		0.531	3.020	0.006	
Computing Attitude	**DV: Overall Score; Y=PosScor** R^2= 0.423, P-Val= 0.004				**DV: Bloom's Low Score Y=PosBlmLo** R^2= 0.471, P-Val=0.001				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.267, P-Val=0.053			
β_{SE} = PosAtdC	-0.011	-1.399	0.175	N.S.	-0.006	-0.761	0.454	N.S.	-0.014	-1.436	0.164	N.S.
β_T=Category	0.053	2.450	0.022		0.047	2.079	0.048		0.051	1.916	0.067	
β_X =Pretest	0.642	3.904	0.000		0.550	4.544	0.000		0.545	2.299	0.031	

Figure 4-11c: Equation/hypothesis 4b, impact of attitude on student learning ($S_E \rightarrow Y$ relation in Figure 4-12); $Y=\alpha + \beta_{SE} S_E + \beta_T T + \beta_X X + e_Y$

In addition to the simple regression analysis (SRA) carried out above, a multiple regression analysis (MRA) was carried out on Equation 4b to consider the impact of both attitude variables (accounting and computing), in order to test for spurious results of using only one attitude variable at a time. This process was necessary to validate the results of the simple regression analysis (SRA) while allowing for the small n size of 28. The detailed results of this analysis can be found in Appendix I-3.

The results of this analysis confirmed the results of the SRA in general with the MRA results producing the same 1% significance levels for the accounting attitude variable (PosAtdA). The MRA produced a somewhat stronger result for the computer attitude variable with a significant negative result at the 10% level, while the SRA produced a negative result that was non-significant being somewhat below the 10% level. The negative coefficient on the computing attitude variable may indicate that a rise in attitude towards accounting resulting in better test performance may be slightly at the expense of attitude towards computing. The detailed results of this analysis can be found in Appendix I-3.

The overall outcome of the impact analysis can be seen in conjunction with the research model in Figure 4-12 for the accounting attitude engagement variable only, given that the computing attitude variable produced a non-significant result.

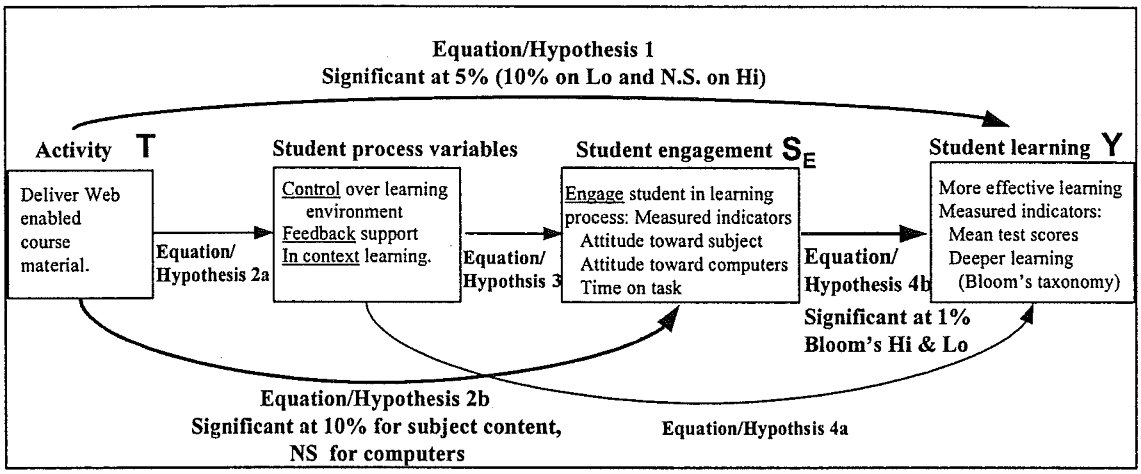

Figure 4-12: Summary of impact analysis for accounting attitude

The following discussion considers the supporting chain of evidence from Figure 4-12.

Summary of impact analysis regarding accounting attitude:

Considering attitude towards accounting: being in the treatment group had a positive impact on student attitude towards accounting (Figure 4-11b) significant at the 10% level and the impact of the improvement in attitude towards accounting had a very strong impact on student learning (Figure 4-11c) significant at the 1% level. This is true for both the Bloom's low portion of the test results (with a P-Value of 0.000) as well as the Bloom's high portion of the test results (with a P-Value of 0.005).

Another way of looking at this can be seen by looking at the proportion of the impact of the treatment (T) on student learning (Y) that is explained by the impact of accounting attitude (S) on student learning (Y) shown in Equation 4b (Figure 4-11c, first row) by looking at the unexplained residual of β_T which shows a coefficient of 0.022. Comparing this to the original coefficient from Equation 1 of 0.043 (Fig. 4-11a first row) demonstrates that accounting attitude (PosAtdA) explains ((0.043-0.022)/0.043)=48.8% of the change in learning, as a result of an improvement in attitude towards accounting, as a result of being in the treatment group. This is quite a large proportion of the change being explained by a single variable. This result is strongly supportive of the central hypotheses of this research.

Based on the three regression equations the impact results may be summarised as follows:

> **Equation 1**: The treatment had a significant positive impact on learning,
>
> **Equation 2b(i)**: The treatment had a significant positive impact on attitude towards accounting, and
>
> **Equation 4b**: Attitude towards accounting had a very significant positive impact on learning.

Summary of impact analysis regarding computing attitude:

There was an overall, non-significant negative impact on learning (from Figure 4-11c) as a result of a positive non-significant impact on attitude towards computing (from Figure 4-11b) from being in the treatment group. A more positive attitude towards computing (the treatment learning environment) produced a negative affect on student learning of accounting. This result is contrary to that which was hypothesised, that an improvement in attitude towards the learning environment would result in an improvement in learning in the content area (accounting). This might be explained by students becoming more interested in computing, and thus less interested in accounting and thus the negative impact on learning. Given the non-significant result one must not make too much of this outcome.

Based on the three regression equations the impact results may be summarised as follows:

For the Attitude towards computers:

Equation 1: The treatment has a strong positive impact on learning,

Equation 2b (ii): The treatment has a positive, but non-significant, impact on the attitude towards computers, and

Equation 4b: The attitude towards computing has a non-significant negative impact on learning.

Comparison of effect size to prior studies

Prior studies using meta-analysis (Kulik et.al., 1980; Kulik & Kulik, 1987; Fletcher-Flinn& Gravatt, 1995) to gain an overall view of multiple studies done on the efficacy of computer supported learning may be used to give a broader view of the results of this study. See the discussion in Chapter 2 under the heading "Effectiveness of computer technology in higher education" for more about these meta-analytic studies. The standard measure used in these studies has been effect size, which "describes in standard deviations units the difference in performance of the experimental and control groups" (Kulik & Kulik, 1987). Although this is a much narrower measure than has been used in this study, it does provide a global comparator for the experimental results. Effect size (Δ) can be computed by subtracting the mean result of the control group ($\bar{X}_c$) from the mean result of the experimental group ($\bar{X}_e$) and then dividing by the standard deviation of the control group (sd_c), as shown in the following equation (Fletcher-Flinn, 1995; Kulik, 1987).

$$\Delta = (\bar{X}_e - \bar{X}_c) / sd_c$$

Where pre-test and post-test results are available Fletcher-Flinn considered that a more accurate result is to subtract the pre-test result from the post-test result to yield a Δ total, as shown in the following equation.

$$\Delta \text{ total} = \Delta(\text{post-test}) - \Delta(\text{pre-test})$$

Results from this study, using this analysis approach can be seen in Figure 4-14.

	$\bar{x}_e$	$\bar{x}_c$	$\bar{x}_e$-$\bar{x}_c$	sd_c	Δ	**Δ Total**
Pretest-Overall	0.662	0.690	-0.028	0.070	-0.40	
Posttest- Overall	0.787	0.761	+0.026	0.063	+0.41	+0.81
Pretest-Bloom's Low	0.677	0.721	-0.044	0.103	-0.43	
Posttest- Bloom's Low	0.831	0.813	+0.018	0.074	+0.24	+0.67
Pretest-Bloom's High	0.646	0.659	-0.013	0.065	-0.20	
Posttest- Bloom's High	0.744	0.710	+0.034	0.071	+0.48	+0.68

Figure 4-14: Effect Size computation for this study
($\bar{x}_e$ and $\bar{x}_c$ from Figure 4-6)

According to Cohen (in Kulik, 1980) where the Δ is 0.20 it is considered to be small, when the Δ is equal to 0.50 or greater they are considered to be medium in size and when Δ is greater than 0.80 results are considered to be large effect sizes. The results of this study as shown in Figure 7-11 on the overall Δ are described as large, with Bloom's Low and High results being medium.

These results may be compared with prior meta-analytic studies to determine how significant the results are. A comparison may be seen in Figure 4-15.

Reference		**Average of effect size**
Kulik et.al., 1980		0.25
Kulik & Kulik, 1987		0.30 overall with the following ranges Published: 0.46; unpublished 0.23 Controlling for instructor effects: 0.24 No control for instructor effects: 0.40 Duration of instruction less than 9 weeks: 0.36
Fletcher & Flinn, 1995		0.24 (for studies from 1987-1992), with more recent studies (1989-92) coming in at 0.33
Results of this study		Overall: 0.81 Bloom's Low: 0.67 Bloom's High: 0.68

Figure 4-15: Effect Size comparison
($\bar{x}_e$ and $\bar{x}_c$ from Figure 4-6)

Given that this study controlled for instructor effects, the results are much higher than the average results shown in previous studies producing approximately three times the effect, indicating further the efficacy of the overall results as demonstrated earlier in the impact analysis.

Summary and conclusion

The overall result of this chapter can be summarised in relation to the hypotheses covered by the experimental portion of the study (as seen in Figure 4-2), as well as other aspects discovered in conjunction with the demographics of the students. On all of the hypotheses the results reported have controlled for whether students were in the treatment or control group.

A summary of the hypotheses and the outcomes on those hypotheses can be seen in Figure 4-16. Under the source of evidence/ Impact analysis column the following guide is used: + = supported, 0 = mixed support, - = not supported, N/A = not applicable. The final column of Figure 4-16 gives a summary of the outcome, showing that the given hypothesis is supported, not supported or mixed support. A synthesis of the information is then presented for each hypothesis.

Hypothesis	**Source of Evidence:**	**Summary of Outcomes**
	Impact Analysis	
Primary Hypothesis:		
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	+	Supported
Impact of web course on process variables		
2a (i). Support for higher student control		N/A
2a (ii). Support for improved feedback		N/A
2a (iii). Support for greater in-context learning		N/A
Impact of web course on engagement variables		
2b (i). Better attitude towards course content	+	Supported
2b (ii). Better attitude towards computers	-	Not Supported

2b (iii). Higher time-on-task		N/A
Impact of process variables on engagement variables		
3a. Process variables affecting better attitude towards course content		N/A
3b. Process variables affecting better attitude towards computers		N/A
3c. Process variables affecting higher time-on-task		N/A
Regarding effective learning		
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		N/A
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning	0	Mixed Support

Figure 4-16: Association of hypotheses with research method and outcome

Results on hypotheses

Overall Hypothesis 1. Web technologies do provide a pedagogically sound foundation for more effective educational systems: It was found that students did perform better on tests (using a pre-test/post-test experimental design) when using the web enabled learning environment with a significance level of 5% on the overall test scores, 10% on Blooms Low results but a non-significant result on the Blooms High results (Figure 4-11a). This can also be seen in the descriptive statistics in Figure 4-7b. Thus this hypothesis is supported by the evidence from the experimental portion of this study, with some reservations on the Bloom's High results.

In addition this overall hypothesis brings together the individual hypotheses and is tested by the impact analysis used in assessing the experimental results. The supporting chain of evidence produced indicates that those in the treatment group had a greater improvement in attitude towards accounting (Hypothesis 2b, Figure 4-11b) and an improvement in attitude towards accounting had a positive impact on student learning (Hypothesis 4b, Figure 4-11c). These results were significant at the 1% level overall, including better results on Bloom's Low scores (significant at the 1% level) and on Bloom's High scores (significant at the 1% level). An additional factor in the measure of effective learning is attitude towards the content area (accounting) and students in the treatment group demonstrated a better result in this area also (as noted under Hypothesis 2b (i) below (see Figure 4-11b). Thus this hypothesis is supported by the evidence from the experimental portion of this study. Further detail on the supporting hypotheses follows.

Hypothesis 2b (i). Better attitude towards course content: Students in the web enabled learning environment had a greater improvement in their attitude towards accounting with results significant at the 10% level (Figure 4-11b). Thus this hypothesis is supported by the evidence from the experimental portion of this study.

Hypothesis 2b (ii). Better attitude towards computers: Students in the web enabled learning environment had no significant improvement in their attitude towards computers (Figure 4-11b), the learning environment for the web enabled tutorials. Thus this hypothesis is not supported by the evidence from the experimental portion of this study.

Hypothesis 4b. Student engagement impact on student learning: Students in the treatment group had a more positive attitude towards accounting (from Hypothesis 2b (i)) and a more positive attitude had very strong positive impact on student learning, significant at the 1% level on the overall test results. The Bloom's Low and Bloom's High results are also significant at the 1% level (see Equation 4b, in Figure 4-11c). However Equation 4b for the computing attitude produces a non-significant result in line with the Equation 2b(ii) results for this variable.

Demographic issues:

None of the demographics variables (Figure 4-9b) of sex, age, ethnicity, prior computing experience and prior accounting experience had a significant affect on student learning overall, nor on the Bloom's Low segment of the pre-test/post-test results. However one of the variables, prior accounting, did have a significant affect at the 5% level on the Bloom's High segment of the pre-test/post-test results.

In addition it was found that older students and ethnic minorities did more poorly on the Bloom's High test segment as a result of being much less likely to have taken accounting previously (Figure 4-9a and 5-9b).

Effect size results

In comparing the results of the experimental portion of this study to prior studies on Computer Assisted Instruction (CAI) effect size is used. The effect size of this study overall was 0.81, with an effect size for Bloom's Low of 0.67 and Bloom's High of 0.68. This is significantly higher than the mean of prior studies which showed an effect size of 0.24 for studies controlling for tutor bias, and 0.33 for an overall mean of more recent studies (1989-1992).

Conclusion

This chapter has presented the process and results of the experimental portion of this study, including a discussion of "effect size" for comparison to prior studies. The overall result is largely one of support for the tested hypothesis and a relatively large effect size in relation to prior studies. Chapter 5 will consider the survey portion of this study including points of overlap with the experimental results covered in this chapter. A full synthesis of the multiple sources of evidence from Chapters 4, 5 and 6 is carried out in Chapter 7.

Chapter 5: Analysis of Survey Data

Introduction and overview

The research design for this project consisted of a case study design with three primary components (as seen in Figure 3-3): an experimental section, a survey section and a qualitative section. This chapter covers the survey portion of this research with Chapter 7 providing a synthesis of the three components.

The survey portion of this study allows the gathering of data from a broad range of students, permitting insight into their views on the learning process and learning environment. Does a web enabled learning environment provide a sound foundation from which students can learn more effectively? This core question is at the heart of this study, and the survey component of this study permits us to ask the students what their experience was. The learning survey also provides data which can be used, in conjunction with the experimental results from Chapter 4, to strengthen the supporting chain of evidence between the cause (a web enabled learning environment) and the hypothesised effect (better student learning) through intervening variables that answer the question "why" did the cause produce the effect. The intervening variables that will be assessed from the learning survey are the student process variables (as seen in the research model in Figure 5-1) which include <u>control</u> over the learning environment, student <u>feedback</u> from the learning environment, and level of <u>in-context</u> learning provided by the learning environment. Also assessed will be the student engagement variable of <u>time-on-task</u>, which was captured on the learning survey. A copy of the survey can be found in Appendix D (treatment group) and Appendix D-1 (control group).

The experimental portion of this study has an impact on the survey portion in that the surveys were administered to students in control and treatment groups. This permits discovery and comparison of student perceptions on the three intervening variables of control, feedback and in-context learning across the control and treatment groups. Further the analysis allows strengthening of the supporting chain regarding how student views on control, feedback and in-context learning affect their learning, positively or negatively, as measured on the pre-test and post-test of the experimental portion of this study. This design also permits assessment of the impact of student process variables of control, feedback and in-context variables on the engagement variables of attitude towards accounting, attitude towards computing and time-on-task.

This chapter covers the design, data gathering and analysis of the survey data from the research programme. The analysis will incorporate descriptive statistics as well as impact analysis (as used with the experimental data in Chapter 4) on the quantitative side. Responses to an open question on the survey will also be analysed to provide further qualitative insights.

This chapter is organised as follows:

- Review of the research model and implications for survey design
- Survey design
- Instrument reliability and evaluation
- Descriptive statistics from learning survey
- Most valuable features of the web enabled learning environment
- Impact analysis on survey data
- Summary of comments from open question on learning survey
- Summary of survey analysis
- Conclusions

Review of the research model and implications for the survey design

This chapter covers the portion of the research model (as seen in figure 5-1) that includes the student process variables of control, feedback and in-context learning as well as the student engagement variable of time-on-task. This chapter also tests the impact of the student process variables on student engagement, thus covering portions of all hypotheses from the Research model as seen in Figure 5-1. Synthesis of these results with the results from Chapter 4 on the experimental analysis will be carried out in Chapter 7.

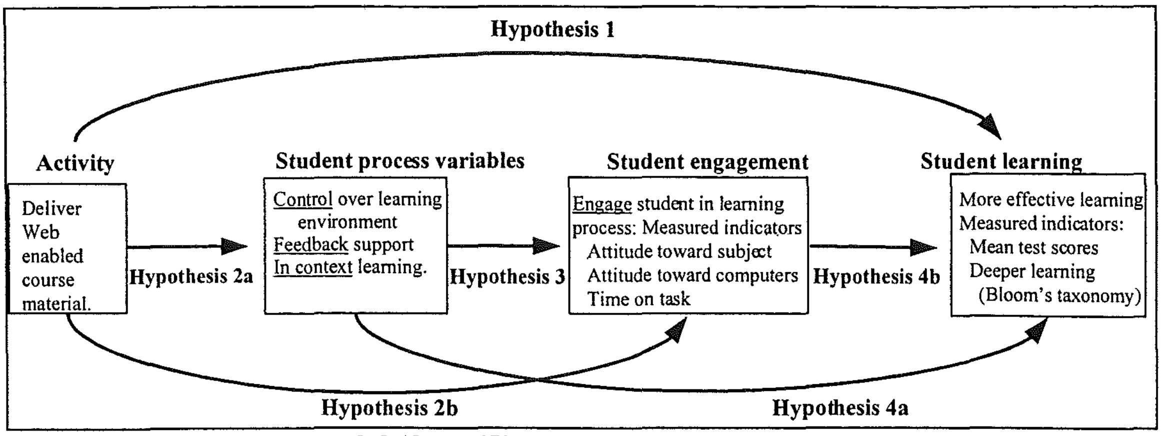

Figure 5-1: Research model (from Figure 3-1)

Figure 5-2 lays out the testable hypotheses (from Chapter 3) and the research methods that will supply evidence regarding those hypotheses with the survey column shaded.

Hypothesis	Research Methods used		
	Exer. Ch. 4	**Survey** Ch. 5	**Qualit.** Ch. 6
Primary:			
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	✓	✓	✓
Impact of web course on process variables			
2a (i). Support for higher student control		✓	✓
2a (ii). Support for improved feedback		✓	✓
2a (iii). Support for greater in-context learning		✓	✓
Impact of web course on engagement variables			
2b (i). Better attitude towards course content	✓	✓	✓
2b (ii). Better attitude towards computers	✓	✓	✓
2b (iii). Higher time-on-task		✓	
Impact of process variables on engagement variables			
3 a. Process variables affecting better attitude towards course content		✓	
3 b. Process variables affecting better attitude towards computers		✓	
3 c. Process variables affecting higher time-on-task		✓	
Regarding effective learning			
4a. Higher levels of student process support will yield more effective learning including better performance on tests, including deeper learning		✓	✓
4b. Higher levels of student engagement will fyield more effective learning including better performance on tests, including deeper learning	✓	✓	✓

Figure 5-2: Association of hypotheses with research methods (from Figure 3-10)

Survey design

This section describes the survey design and includes: the objectives of the survey portion of the study, the procedures followed in carrying out the survey and a discussion on the construction and validation of the survey instrument.

Survey objectives

The objectives of the survey component of this study include:

- To establish a supporting chain of evidence from which to support or refute the research hypotheses with a particular focus on the student process variables of control, feedback and in-context learning and the student engagement variable of time-on-task

- To gain a broader understanding of student views on the learning process and learning environment, including views on most valuable and most useful features of the web enabled learning environment

- To discover any additional learning factors that were not included in the original research design

Survey procedures

1. Surveys were administered to each tutorial within the treatment group and the control group during the final (third) tutorial of the treatment period, the purpose being to discover student opinions on various aspects of the learning process and environment.

2. The survey for each group (treatment and control) incorporated items dealing with the three primary student process variables being measured: control, feedback and in-context as well as items to discover time-on-task and an open question. Given the different nature of the two learning environments, many of the questions were different (although related) between the two surveys. However common questions on each of the three main student process variables were included. Copies of the two surveys can be seen in Appendices

D and D-1. A further discussion on the construction and validation of these instruments is included in a following portion of this section entitled Design of Survey Component.

3. During the third tutorial (final one of the treatment period) of the series, tutors distributed the survey to all students present in the tutorial. Students completed the survey during the last portion of the tutorial period and returned to the tutor before leaving the room. A copy of the tutor instructions may be seen in Appendix J.

4. Students who were not present in the tutorial room were given an opportunity to collect a survey and complete it in the few days following the last tutorial. This was announced in lecture.

Survey questions

See Appendices D and D-1 for a copy of the treatment and control group surveys which specify the questions asked.

Design of survey component

As noted earlier in the procedures section, the primary instrument to be used in this part of the study is a learning survey for each group (treatment and control). The following describes these instruments (see Appendix D and D-1) and their validation.

There was a different survey for the control group (face-to-face tutorials) and the treatment group (web enabled tutorials). Both surveys covered the same student process and engagement variables. The ISWorld site [HREF 4] was reviewed for possible surveys and/or survey items for use with this research. None were found that were applicable to the current research. The following process was used to construct the learning survey.

- The learning survey for the treatment group was constructed on the basis of the research model (see Figure 5-1) with multiple items for each of the primary "student process" variables of: control, feedback and in-context learning. Given the formative nature of this research, appropriate validation statistics were computed in conjunction with the data analysis, as described later in this chapter. Also included were questions about the time taken for the tutorials (time-on-task), number of tutorials taken, if the material was accessed from outside tutorial times or from off campus. There was also an open question for additional feedback included.

- Feedback was sought from the three course lecturers on the survey's readability and applicability, with feedback incorporated into the subsequent version of the survey.

- This modified survey was then tested with a group of 20 first year students. Student volunteers from a different first year course, who were not taking the accounting course, were sought to test the web enabled course-ware. These students worked through the on-line course content, providing written and oral feedback on the material, which was used to improve the course-ware prior to its use during the experimental period. At the end of this session the 20 first year students were asked to complete the treatment group learning survey, and provide written and oral feedback on the survey. This feedback was then incorporated into the final version of the treatment group survey which was used in the research.

- The treatment group survey was then used as a model for constructing the control group survey for the face-to-face environment. The control group survey was then reviewed by the three course lecturers, regarding the survey's readability and applicability, with feedback incorporated into the subsequent version of the survey.

Instrument reliability and evaluation

Cronbach's alpha was computed for both the control group learning survey and the treatment group learning survey to provide some assurance as to the reliability of the instruments. The control group Cronbach alpha was 0.845 and the treatment group Cronbach alpha was 0.814 (after removing Qs 4, 8, 7, 16 and 17 all which had very high "no useage" scores; see Appendix K for details). Given the formative nature of the surveys these scores were considered to give good assurance as to the reliability of the instruments (Nunnally, 1978; Lampe et al, 1999).

Traditional factor analysis was considered, but was rejected due to the fact that the questions used on the surveys were considered to be formative, rather than reflective and thus eliminating the concept of latent factors (Chin, 1998). Latent factors are reflected in the survey item responses (with the expectation that the survey items should necessarily correlate strongly on certain factors). A complicating issue was that the Treatment and Control group surveys were not identical although intending to measure the same three areas (Control, Feedback and In-context) for the two different learning environments. In the light of these issues alternatives to factor analysis were considered including:

1. Use just the common questions on each survey (two questions for each area, (control, feedback and in-context).

2. Create three composite variables for all questions on each survey related to the three areas of control, feedback and in-context, averaged to remove the bias due to having more questions on the Treatment survey. Also questions from the treatment survey would need to be eliminated where a large number (approximately 30% of more) of participants did not use the feature.

3. Using the one "overall" question for each of the three areas (control, feedback and in-context) that was common to both surveys.

It was decided to perform items 2 and 3 above as part of the analysis to gain maximum insight into the data. Using two methods also provides for triangulation of the results, reducing the likelihood of coming to spurious conclusions.

Creation of composite variables

The composite variables (item 2 above) were constructed as seen in Figure 5-3, which shows the question numbers from each survey that were included in the composite variables (see Appendix K to match question numbers with the actual questions). The question numbers in bold represent the common questions on the two surveys, with two common questions on control and in-context, but only one common question on Feedback (the second common question was eliminated, see discussion below).

Composite Variable Name and Description	**Name of original variables included in composite**							
	Treatment Survey				**Control survey**			
Control (represents control over learning environment)	6	9	**13**	**18**	**7**	**11**		
Feedback (represents feedback in learning environment)	2	**11**			**2**	4	6	9
In-context (represents items that create a cohesive, situated learning environment	**3** 5	10 12	**15**	19	1	**3**	**5**	8

Figure 5-3: Construction of composite variables
(see Appendices C and D for original survey questions)

For the **Control** composite in the Treatment Survey: question 1 (Ability to choose my Episode type) was originally considered to be involved in control, but was eliminated, since it appeared to have very little impact on student learning, as can be seen in the descriptive statistics in Figure 5-8 with a score of only 3.62. This variable will be analysed and discussed later in the descriptive statistics portion of this chapter.

For the **Feedback** composite in the Treatment Group Survey: questions 4 (two way email with tutors), 8 (on-line discussion groups) and 16 (two way email with students) were originally considered to be involved in feedback, but due to the lab based flexible learning environment in which the work was delivered, many students did not use the features referred to in these survey questions. These variables were thus eliminated from the composite due to a very high "no useage" score (in excess of 30%) as discovered after frequency tables were run (see Appendix K for details). A further variable, question 14 which was one of the common questions between the two surveys (relating to other students) was originally considered to be involved in feedback, but after further consideration was eliminated as being too distant from the concept of feedback being used for this research. The same questions was eliminated from the Control Group Survey. These variables will be analysed and discussed later in the descriptive statistics portion of this chapter.

For the **In-context** composite in the Treatment Survey: question 7 (FAQ help) was originally considered to be involved in creating context, but due to the lab based flexible learning environment in which the work was delivered, many students did not use the feature referred to in this survey question. Question 17 (text-book references) was originally considered to be involved in creating context, but due to the way in which the courseware was created, many students did not use the feature. Both of these variables were thus eliminated from the composite due to a high "no useage" score (in excess of 30%) as discovered after frequency tables were run (see Appendix K for details). These variables will be analysed and discussed later in the descriptive statistics portion of this chapter.

Descriptive statistics

Initial outcomes from the surveys conducted with the treatment and control groups can be seen in Figures 5-4 (control), 5-5 (feedback), 5-6 (in-context) and 6-6 (other questions). These figures show the results of the control group alongside the treatment group. The common survey questions are shown first in each table, followed by the questions unique to either the control or treatment group survey. A copy of these same results (all in a single table) may be found in Appendix K, sorted into question number order based on the treatment group learning survey. A copy of the learning surveys can be found in Appendices D and D-1. The focus of the surveys was the impact of the learning environment (web mediated for the treatment group and traditional face-to-face discussions for the control group) on student learning. This was captured in survey items headed "This aspect helped me learn better" followed by a 6 point Likert scale (1=strongly disagree and 6=strongly agree).

It should be noted that the treatment group means were computed after elimination of "no useage" responses (as shown in the final column of Figures 5-4, 5-5 and 5-6).

Some of the features of the web learning environment of the treatment group were not used by some of the students. These responses were coded as a zero (0) response. These "no useage" responses were removed from the totals prior to computation of the means shown in Figure 5-4, 5-5 and 5-6 so as to not skew the results by the opinions of those who did not utilise the feature. The number of participants was: control group n=84, treatment group n=75 (as shown in Figure 4-6).

In reviewing Figure 5-4, it can be seen that both the control and the treatment groups were above the neutral point (3.5) on all control questions. However the treatment group was considerably higher on the common questions, also showing particularly strong responses (above 5.0) regarding the flexibility of timing and control over pace.

Mean score or other statistic

Survey Question/ Description	Ctrl Group	Treatmt Group	Trtmt Grp No Useage
Ability to control the pace of my learning (I could take as much or little time as I needed)	4.05	5.26	0
Control over my learning environment	3.93	4.62	0
Flexibility of timing and accessibility to material (24 hour access to WWW materials)	-	5.52	6
Control provided by WWW browser and hypertext environment	-	4.27	0
Ability to choose my "Episode" type	-	3.62	8

Figure 5-4: Comparison of means for control questions on surveys

In figure 5-5, on feedback, the control group scored better regarding relating to other students in the tutorial (not surprisingly), but again the treatment group was more positive overall, being particularly positive about the rapid automated feedback from the on-line testing. In regard to the treatment group responses on the feedback variable, it should be noted the relatively large number of students who did not use the email and discussion group features of the application. This was not surprising considering the treatment group did their work in a computer lab with a tutor who could respond to their questions face-to-face.

Mean score or other statistic

Survey Question/ Description	Ctrl Group	Treatmt Group	Trtmt Grp No Useage
Overall level of feedback	3.85	4.36	0
Relating to other students in tutorial	4.04	3.40	16
Getting rapid automated feedback on the tests	-	5.34	1
The ability to have two-way (email) communication with tutors	-	4.26	40
The ability to have two-way (email) communication with students	-	4.10	44
Availability of on-line discussion groups	-	3.94	40
Solutions to preparation problems	4.55		
Tutor's answers in tutorial	4.41		
Solutions to tutorial questions	4.30		

Figure 5-5: Comparison of means for feedback questions on surveys

In Figure 5-6, regarding the in-context variable, once again the treatment group views were more positive. Although none of the responses were above 5.0, students were particularly positive about the excel spreadsheets, on-line dictionary and the "hints" button on the tests.

Mean score or other statistic

Survey Question/ Description	Ctrl Group	Treatmt Group	Trtmt Grp No Useage
(Tutorial materials and discussion) or (The AFIS On-line system) provided a cohesive, consistent, in-context, learning system	4.07	4.47	0
Use of clarifying examples	4.15	4.14	7
Use of excel practice spreadsheets	-	4.88	3
Availability of the dictionary on-line	-	4.67	11
Use of the "hints" button on the tests	-	4.61	4
The use of Episode scenarios to add context to learning	-	4.51	0
Availability of the Frequently Asked Questions (FAQs) Help	-	4.14	24
Availability of text-book references on-line	-	4.04	29
Doing the preparation problems	4.74		
In tutorial discussion of questions and problems	4.21		

Figure 5-6: Comparison of means for in-context questions on surveys

Probably the most surprising result from the survey is reflected in Figure 5-7 regarding the time-on-task question (hours spent on tutorial material), with the control group indicating 50% more time spent. This must be considered in the light of the treatment group outperforming the control group on the pre-test/post-test comparison. This would seem to indicate that perhaps students learn more quickly with the web enabled material when compared to traditional face-to-face tutorials. Regarding the treatment group, a large number of the students accessed the material from outside of the normal tutorial times (66.2%), while a reasonable number accessed the material from off campus (23.3% via dial-up connections from home). Both groups attended an equivalent number of tutorials with no significant difference between them.

Mean score or other statistic

Survey Question/ Description	**Ctrl Group**	**Treatmt Group**
Time-on-task: Hours spent on tutorial material	6.27	4.01
Tutorials attended (out of three)	2.72	2.85
Did you access the WWW tutorial material outside of tutorial hours? (% who said yes)	-	66.2%
Did you access the WWW tutorial material from off campus? (% who said yes)	-	23.3%

Figure 5-7: Comparison of means for other questions on surveys

Most valuable features of the web enabled learning environment

Figure 5-8 shows the treatment group responses from the material presented in Figure 5-4, 5-5 and 5-6, sorted in order of mean scores. This clearly displays the areas that students believed most helped them learn better, and thus may be considered to be the most valuable features of the web enabled learning environment from the students' perspective.

Survey Question/ Description	Mean Score
Flexibility of timing and accessibility to material (24 hour access to WWW materials)	5.52
Getting rapid automated feedback on the tests	5.34
Ability to control the pace of my learning (I could take as much or little time as I needed)	5.26
Use of excel practice spreadsheets	4.88
Availability of the dictionary on-line	4.67
Control over my learning environment	4.62
Use of the "hints" button on the tests	4.61
The use of Episode scenarios to add context to learning	4.51
(Tutorial materials and discussion) or (The AFIS On-line system) provided a cohesive, consistent, in-context, learning system	4.47
Overall level of feedback	4.36
Control provided by WWW browser and hypertext environment	4.27
The ability to have two-way (email) communication with tutors	4.26
Availability of the Frequently Asked Questions (FAQs) Help	4.14
Use of clarifying examples	4.14
The ability to have two-way (email) communication with students	4.10
Availability of text-book references on-line	4.04
Availability of on-line discussion groups	3.94
Ability to choose my "Episode" type	3.62
Relating to other students in tutorial	3.40

Figure 5-8: Most valuable features of the web based learning environment

The results from Figure 5-8 may be viewed in five sections separated by gaps in the descending series of results: outstanding effect (5.26 and higher), strong effect (4.26 to 4.88), moderate effect (3.94 to 4.14), neutral effect (3.62) and negative effect (3.40).

Of the three outstanding effect features, two were concerned with control over timing and pace of learning while the third top feature dealt with the rapidity of feedback from the on-line tests.

The strong effect group largely consisted of in-context variables, topped by the excel practice spreadsheets and the on-line dictionary. Also included were the overall control and feedback variables.

The moderate effect group are dominated by in-context and feedback variables that were high on "no-useage" responses (see Figures 6-5 an 6-6) including availability of FAQs, two-way email and discussion groups.

When students first attended the treatment tutorials they were given three options as to the scenario background they would work in: a CD shop, a gourmet deli or an up-market clothing store. In Figure 5-8 this is represented by the neutral effect item, "ability to choose my Episode type ", demonstrating students' indifference to having multiple scenarios to choose from. It appears that this control effect item can be dispensed with in future course design work.

The negative effect item (only weakly negative), "relating to other students in tutorial", seems to show a preference for more contact and discussion with other students.

Impact analysis on survey data

Impact analysis, when used in a formative way, provides evidence regarding the impact of the treatment in two areas. Firstly as to the extent that the treatment did or did not have an impact on the outcome of interest, in this case student learning. Secondly as to the reasons why the treatment had the impact that it did. Also refer to the section entitled Impact Analysis in the later part of Chapter 3 for further background.

Although the survey was not performed in a pre-test/post-test design, its analysis using the impact analysis approach used in Chapter 4 will shed additional light on the outcomes of this research. These results need to be considered in conjunction with the descriptive analysis of survey data performed earlier in this chapter and the impact analysis of the experimental data from Chapter 4.

Overview of regression analysis for survey data

This analysis is based on the student process variables of control, feedback and in-context learning, including both the regressions on the composite variables as well as the overall questions, as noted in the previous section. Discussion and explanation of the results are given after Figure 5-11 which summarises all of the regression results.

The impact analysis will deal with a set of equations in line with the study hypotheses, the results of which will be synthesised with the results from Chapter 4 (experimental analysis) in Chapter 7. These equations, representing the equivalent numbered hypothesis, are shown below and are mapped on to the research model in Figure 5-9 for ease of understanding.

Equation 2a. The direct impact of the treatment (T, the activity) on each of the student process variables (S_P, via the measured variables of control, feedback and in-context learning)

$$S_P = \alpha' + \beta_T' T + e_{SP}$$

Equation 2b. The direct impact of the treatment (T, the activity) on the student engagement variable of time-on-task (S_E)

$$S_E = \alpha' + \beta_T' T + e_{SE}$$

Equation 3. The direct impact of the student process variables (S_P) on the student engagement variables (S_E); controlling for the treatment dummy (T):

$$S_E = \alpha + \beta_{SP} S_P + \beta_T T + e_{SE}$$

Equation 4a. The impact of the student process variables (S_P, via the measured variables of control, feedback and in-context learning) on student learning (Y), controlling for pre-test results plus the additional impact of the treatment (T, the activity) on student learning

$$Y = \alpha + \beta_{SP} S_P + \beta_X X + \beta_T T + e_Y$$

Equation 4b. The impact of the student engagement variable of time-on-task(S_E) on student learning (Y), controlling for pre-test results plus the additional impact of the treatment (T, the activity) on student learning

$$Y=\alpha + \beta_{SE}S_E + \beta_X X + \beta_T T + e_Y$$

The unit of analysis in this section is at the level of the tutorial group, with tutorial groups randomly assigned to either the control or treatment groups, incorporating the average scores of the 28 tutorial groups (see the section entitled Quality of Research Design in Chapter 3, Research Design for further discussion on this). These are represented by the treatment dummy variable in the regression equations as T. Student learning (Y) is measured by the pre-test/post-test results from the experimental portion of this study (see Chapter 4 for analysis).

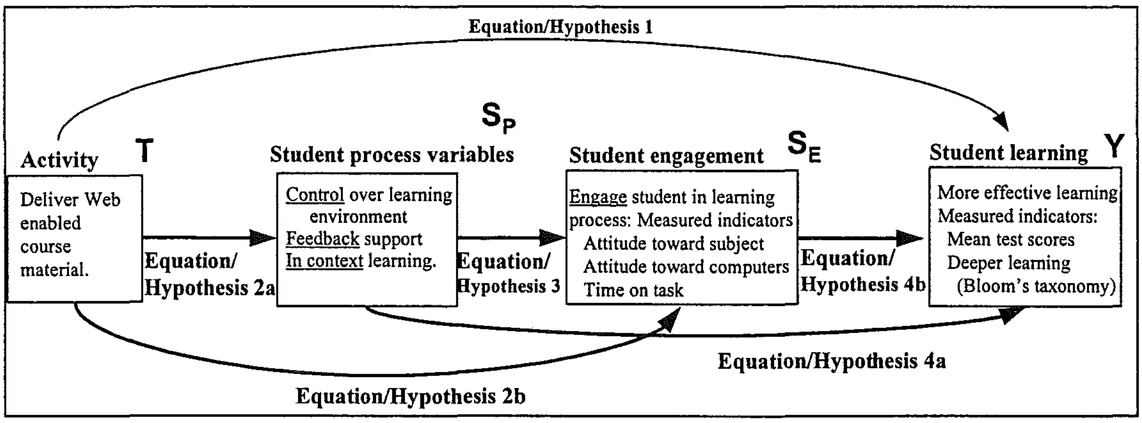

Figure 5-9: Research model showing regression equations

Figures 5-10a, 5-10b, 5-10c, 5-10d and 5-10e summarise the results for the regressions carried out using the equations described in the previous section. The results show the impact of the treatment (T) on content learning (Y), through the intervening student process and student engagement variables A positive coefficient indicates that the results are better for the treatment group than the control group, a negative coefficient indicates that the results are worse for the treatment group than the control group.

The results from Figure 5-10a, 5-10b, 5-10c, 5-10d and 5-10e can best be read by viewing the significance column (Signif) for whether the results are statistically significant (based on the P-Val) together with the coefficient (coef) column which shows the direction of the result (positive or negative). These results are discussed in detail in the section following Figure 5-11. Although it is most common to use a significance level of 0.05 as the cutoff for a significant result, a number of results at the 0.10 level have been commented on in the following section. This is due to the exploratory and formative nature of this study and the importance of avoiding Type 2 errors, that of accepting the null hypothesis, when attempting to discover important influencing factors in an exploratory study. While this will cause results of the study to be a bit more tentative, it will also mean that emerging learning factors will not be overlooked.

Results regarding hypothesis 2a: Impact of treatment on process variables

The results of Equation 2a are seen in Figure 5-10a. As noted at the end of the earlier section entitled "Instrument reliability and evaluation" statistics were run on both the composite variables for control, feedback and in-context as well as on the one overall variable for each of these process variables. It was found that the overall variable simply confirmed the results of the composite variables and so for the sake of parsimony is not reported in Figure 5-10a. The results of Equation 2a show that those students in the treatment group had a higher sense of control and feedback, significant at the 1% level, but that the in-context variable was not significant. Thus this hypothesis is supported for control and feedback but not for in-context learning.

Hypothesis 2a (i)	**DV: Control;** R^2= 0.487, P-Val= 0.000			
	Coef	T	P-Val	Signif
$\beta_T{}'$=Category	0.818	4.964	0.000	1%
Hypothesis 2a (ii)	**DV: Feedback;** R^2= 0.241, P-Val= 0.008			
$\beta_T{}'$=Category	0.454	2.874	0.008	1%
Hypothesis 2a (iii)	**DV: In-context;** R^2= 0.004, P-Val= 0.757			
$\beta_T{}'$=Category	-0.052	-0.312	0.757	N.S.

Figure 5-10a: Equation/hypothesis 2a, Impact of treatment on process variables ($T \rightarrow S_P$ relation in Figure 5-11);

$S_P = \alpha' + \beta_T{}' T + e_{SP}$; (N.S. means non-significant, DV mean dependent variable)

Results regarding hypothesis 2b (iii): Impact of treatment on engagement variable of time-on-task

The results of Equation 2b are seen in Figure 5-10b and show that those in the treatment group spent considerably less time-on-task, significant at the 1% level. Thus this hypothesis is not supported.

	DV: Time; R^2= 00.336, P-Val= 0.001			
	Coef	T	P-Val	Signif
$\beta_T{'}$=Category	-1.822	-3.629	0.001	1%

Figure 5-10b: Equation/hypothesis 2b (iii), Impact of treatment on engagement variable of time-on-task
($T \rightarrow S_E$ relation in Figure 5-11);

$S_E = \alpha' + \beta_T{'}\,T + e_{SE}$; (N.S. means non-significant, DV mean dependent variable)

Results regarding hypothesis 3: Impact of process variables on engagement variables

This section will look at the interaction and impact of the student process variables on the student engagement variable of time-on-task plus the engagement variables covered in the experimental portion of this study from Chapter 4. This is equation 3 based on hypothesis 3 from the research model (Figure 5-9).

This equation deals with the impact of the student process variables (control, feedback, and in-context) upon the student engagement variables (attitude towards accounting, attitude towards computers and time-on-task) bringing together material from Chapter 4 and material from earlier in this chapter. This regression equation was run in two forms, i) for a single process variable impact (SRA) and ii) impact of all three process variables in a multiple regression (MRA). The reason for running the regression equations in both forms was due to the small number of tutorials (28) representing the data for the control and treatment groups. The simple regression results are more robust with a small n, but raise the question of interactions between the process variables. The multiple regression addresses this issue, but is open to criticism on the grounds of the small n giving unreliable results in multiple regression situations. By running the regression equations both ways, confirmatory evidence is obtained to deal with this catch 22. Equation three consists of:

The direct impact of the student process variables (S_P) on the student engagement variables (S_E); controlling for initial pre-test results on the engagement variables (S_E') and treatment dummy (T):

Equation 3i (SRA): $S_E = \alpha + \beta_{SP}S_P + \beta_{SE'}S_E' + \beta_T T + e_{SE}$

Equation 3ii (MRA): $S_E = \alpha + \beta_{SPc}S_{Pc} + \beta_{SPf}S_{Pf} + \beta_{SPi}S_{Pi} + \beta_{SE'}S_E' + \beta_T T + e_{SE}$

In Figure 5-10c the results of running Equations 3i and 3ii are displayed for all three engagement variables and labelled in line with Figure 5-2 as 3a, 3b and 3c. The first column shows the dependent variable being tested, preceded by the equation designation 3a (i), 3a (ii), 3b (i) etc. The dependent engagement variables are: attitude towards accounting, attitude towards computers and time-on-task.

DV=Engagement Variables (S_E)	**Equation 3: $S_P \rightarrow S_E$ relation**			
		Coef.	**P-Val**	**Signif.**
3a(i). Accounting attitude	Control	0.202	0.615	N.S.
SRA	Feedback	-0.329	0.440	N.S.
	In-context	-0.307	0.445	N.S.
3a (ii). Accounting attitude	Control	0.551	0.261	N.S.
MRA	Feedback	-0.409	0.535	N.S.
	In-context	-0.297	0.625	N.S.
3b (i). Computer attitude	Control	0.512	0.301	N.S.
SRA	Feedback	0.250	0.634	N.S.
	In-context	0.288	0.564	N.S.
3b (ii). Computer attitude	Control	0.522	0.400	N.S.
MRA	Feedback	-0.159	0.860	N.S.
	In-context	0.138	0.870	N.S.
3c (i). Time-on-task	Control	0.712	0.241	N.S.
SRA	Feedback	-0.158	0.805	N.S.
	In-context	-0.590	0.326	N.S.
3c (ii). Time-on-task	Control	1.307	0.071	10%
MRA	Feedback	0.190	0.841	N.S.
	In-context	-1.367	0.126	N.S.

Figure 5-10c: Equation/Hypotheses 3a, 3b and 3c: Impact analysis of process variables (S_P) on engagement variables (S_E)
(N.S. means non-significant, DV mean dependent variable)

Regarding the impact of students having a better sense of control, feedback and in-context learning on accounting attitude and attitude towards computers, Figure 5-10c shows that the impact appears to be minimal with little explanatory power regardless of whether simple or multiple regression is used. There does not appear to be a substantial impact of the student process variables upon attitude. Thus these hypotheses are not supported by this evidence.

However Figure 5-10c does show an impact of the control process variable on time-on-task as being significant at the 10% level when using multiple regression. This is not a very strong impact and must be read with some reservations in the light of the small n being used in this multiple regression equation. However it is an interesting finding, possibly indicating that when students feel they have more control, they will put in more time-on-task.

Results regarding hypothesis 4a: Impact of process variables on student learning

The results of Equation 4a are seen in Figure 5-10d. As noted at the end of the earlier section entitled "Instrument reliability and evaluation" statistics were run on both the composite variables for control, feedback and in-context as well as on the one overall variable for each of these. It was found that the overall variable simply confirmed the results of the composite variables and so for the sake of parsimony are not reported in Figure 5-10d. Equation 4a results show that the process variables did not have a significant impact on student learning as demonstrated in the pre-test/post-test results. The only exception to this was a negative impact of feedback on Bloom's Low results, significant at the 10% level. Thus this hypothesis is not supported.

	Dependent Variable											
Control	**DV: Overall Score; Y = PosScor** R^2= 0.389, P-Val= 0.007				**DV: Bloom's Low Score; Y=PosBlmLo** R^2= 0.459, P-Val=0.002				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.262, P-Val=0.059			
Independent Variables	Coef	t	P-Val	Signif	Coef	t	P-Val	Signif	Coef	t	P-Val	Signif
β_S = Control	-0.018	-0.690	0.499	N.S.	-0.002	-0.070	0.945	N.S.	-0.042	-1.354	0.188	N.S.
β_T=Category	0.056	1.967	0.061		0.043	1.460	0.157		0.073	2.043	0.052	
β_X =Pretest	0.575	3.304	0.003		0.532	4.283	0.000		0.384	1.915	0.068	
Feedback	**DV: Overall Score; Y = PosScor** R^2= 0.411, P-Val= 0.005				**DV: Bloom's Low Score; Y=PosBlmLo** R^2= 0.518, P-Val=0.000				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.224, P-Val=0.102			
β_{SP} = Feedback	-0.030	-1.178	0.250	N.S.	-0.044	-1.717	0.099	10%	-0.024	-0.738	0.468	N.S.
β_T=Category	0.055	2.386	0.025		0.059	2.579	0.017		0.050	1.665	0.109	
β_X =Pretest	0.559	3.299	0.003		0.478	4.028	0.001		0.423	2.093	0.047	
In-Context	**DV: Overall Score; Y = PosScor** R^2= 0.387, P-Val= 0.008				**DV: Bloom's Low Score; Y=PosBlmLo** R^2= 0.504, P-Val=0.001				**DV: Bloom's High Score; Y=PosBlmHi** R^2= 0.206, P-Val=0.130			
β_{SP} =In-Context	-0.015	-0.634	0.532	N.S.	-0.036	-1.478	0.152	N.S.	-0.000	-0.004	0.997	N.S.
β_T=Category	0.042	1.964	0.061		0.037	1.795	0.085		0.039	1.475	0.153	
β_X =Pretest	0.589	3.464	0.002		0.489	4.088	0.000		0.436	2.141	0.042	

Figure 5-10d: Equation/hypothesis 4a, Impact of process variables on student learning
($S_P \rightarrow$ Y relation in Figure 5-11);

$\mathbf{Y=\alpha + \beta_{SP}S_P + \beta_T T + \beta_X X + e_Y}$; (N.S. means non-significant)

Results regarding hypothesis 4b: Impact of engagement variable of time-on-task on student learning

The results of Equation 4b are seen in Figure 5-10e. Equation 4b results show that the engagement variable of time-on-task, while having a positive impact on student learning if in the treatment group, the impact was not significant. This was true for overall learning as well as the results on the Bloom's Low and Bloom's High portions of the post-test. Thus this hypothesis is not supported.

	Dependent Variable											
Time	**DV: Overall Score;** **Y = PosScor** R^2= 0.409, P-Val= 0.005				**DV: Bloom's Low Score;** **Y=PosBlmLo** R^2= 0.485, P-Val=0.001				**DV: Bloom's High Score;** **Y=PosBlmHi** R^2= 0.207, P-Val=0.129			
β_{SP} = Time	0.010	1.141	0.265	N.S.	0.009	1.114	0.277	N.S.	0.002	0.150	0.882	N.S.
β_T=Category	0.064	2.308	0.030		0.059	2.235	0.035		0.043	1.183	0.248	
β_X =Pretest	0.702	3.810	0.001		0.562	4.672	0.000		0.458	1.838	0.078	

Figure 5-10e: Equation/hypothesis 4b, Impact of time-on-task engagement variable on student learning
($S_E \rightarrow Y$ relation in Figure 5-11);

$Y=\alpha + \beta_{SE}S_E + \beta_T T + \beta_X X + e_Y$; (N.S. means non-significant)

Explanation of regression results on survey data

The overall outcome of the survey impact analysis can be seen in conjunction with the research model in Figure 5-11, and is explained in detail in this section.

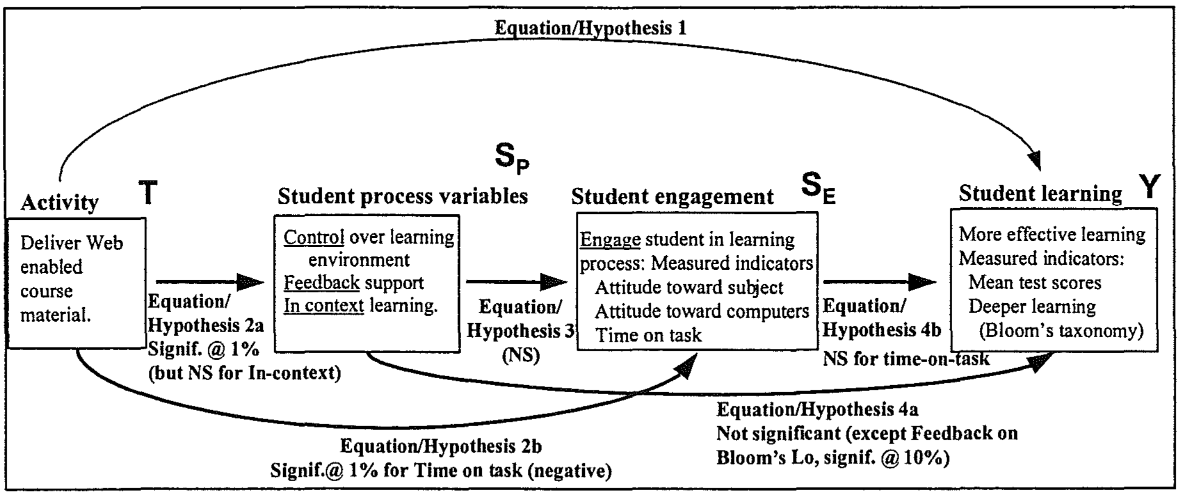

Figure 5-11: Summary of impact analysis for feedback, control and time-on-task

The following sections discuss the outcomes (as shown in Figure 5-11) for each of the variables considered in this impact analysis: control, feedback, in-context learning and time-on-task. The results of the impact analysis for hypotheses 3a, 3b and 3c were non-significant and are therefor not discussed further for the sake of parsimony, with the exception of the process variable of control on the engagement variable of time-on-task (significant at the 10% level).

Summary of impact analysis regarding the Control student process variable

Based on the results summarised in Figures 6-10a, to 6-10e, and considering the Control student process variable, the treatment had a strong positive impact on sense of control (significant at the 1% level) but sense of control had a weak negative (non-significant) impact on Y, student learning. Thus the Control student process variable had no explanatory power regarding the improvement in student learning shown in Equation 1 results (from Figure 4-11a in Chapter 4). Overall, students believed they had better control and were learning better in the treatment group, but actual performance was neutral when considering how positive the student was about levels of control.

Summary of impact analysis regarding the Feedback student process variable

Based on the results summarised in Figures 5-10a to 5-10e, and considering the Feedback student process variable, the treatment had a strong positive impact on perceived levels of feedback (significant at the 1% level) but perceived levels of feedback had a weak negative (non-significant) impact on Y, student learning. Thus the Feedback student process variable had no explanatory power regarding the improvement in student learning shown in the Equation 1 results (from Figure 4-11a in Chapter 4). The exception to this was on Bloom's Low results with a 10% significance level (negative impact), which might be due to some overly optimistic students not quite grasping some of the basics of accounting. Overall, students believed they had better feedback and were learning better in the treatment group, but actual performance did not confirm this when considering how positive the student was about levels of feedback.

Summary of impact analysis regarding the In-context student process variable

Based on the results summarised in Figures 5-10b to 5-10e, and considering the In-context student process variable, the treatment had a non-significant impact on students sense of in-context learning and the in-context learning variable had a non-significant impact on student learning. Thus the In-context student process variable has no explanatory power regarding the improvement in student learning shown in the Equation 1 results (from Figure 4-11a in Chapter 4). Overall, students were neutral regarding the more cohesive/in-context learning environment.

Summary of impact analysis regarding Time-on-task

Based on the results summarised in Figures 5-10a to 5-10e, and considering the time-on-task student engagement variable, the treatment had a very strong negative impact on time spent in studying (significant at the 1% level) and the process variable of control had a significant impact on the engagement variable of time-on-task (significant at the 10% level), and time-on-task had a weak positive (non-significant) impact on Y, student learning shown in the Equation 1 results (from Figure 4-11a in Chapter 4). Overall, students learn somewhat better in the treatment group, having spent significantly less time, thus appearing to have an efficiency impact, with less time-on-task. This outcome is contrary to the posited theory, and should be examined more closely in future research.

Overall assessment

In overall terms, the treatment had a strong positive impact on student learning (statistically significant at the 0.05 level from Figure 4-11 in Chapter 4), but the treatment had a much stronger positive effect on student processes within the web enabled learning environment (statistically significant at the 1% level for control and feedback variables but not significant for In-Context variable from Figure 5-10a). However this strong impact on student processes within the web enabled learning environment does not explain the strong positive impact on student learning, so something else must be causing the improvement. Some of the potential causes were discussed in Chapter 6 and Chapter 4 and will be synthesised with the qualitative analysis (Chapter 6) and experimental analysis (Chapter 4) in Chapter 7.

In addition to the student process variables, the analysis of the engagement variable of time-on-task indicated that students in the treatment group studied significantly less (statistically significant at the 1% level) but still outperformed the control group in student learning (but with a non-significant result).

It was also found that the process variables of feedback and in-context learning had no significant impact on student engagement (attitude towards subject content, attitude towards computers and time-on-task). However Figure 5-10c does show an impact of the control process variable on time-on-task as being significant at the 10% level when using multiple regression.

The next section of this chapter will look at the results of student comments from the open question that was contained in the student learning surveys (as seen in Appendix D and D-1 at the end of the survey).

Summary of comments from learning survey open question

The learning survey (see Appendix D) contained one open question "What other comments do you have about the WWW tutorials?". This question was intended to elicit further comment to broaden the understanding of student experience in the use of the web enabled environment. This section describes the objectives, procedures and outcomes in regard to this open question.

Objectives

The objectives for summarising comments made on the open question from the learning survey included:

1. To gain insights from students' first hand experience of the learning system, including positive and negative aspects of their experience.

2. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the process variables of control, feedback and in-context learning.

3. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the engagement variables of attitude towards accounting and toward computing.

4. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. The learning survey (see Appendix D) included an open question that permitted students to make any other comments they would like about the web enabled tutorials.

2. These comments were captured in an archive and analysed to enrich the qualitative data of this research.

3. The archive of comments was analysed and categorised for common themes.

Summary of outcomes

Figure 5-13 contains a summary of student comments given on the learning survey open question. Detailed comments are included in Appendix L. Figure 5-13 is organised with the first and second column showing the type of comment (compliment 1 to 8 or complaint 1 to 8), with the third column indicating the number of times this type of comment was made. The final column provides indicative comments that fell into this category. These comments are discussed below in connection with the objectives noted earlier.

Positives and negatives of students' experience with learning system

The positive and negative comments dealt largely with issues covered below regarding the hypotheses of this study and formative comments. Overall, compliments outweighed complaints by 74 to 46, and the feedback from this source was valuable in validating the data gathered from other sources noted earlier in this chapter and in Chapters 4 and 6.

Interestingly there were a number of one-off comments which provide some insight into the diversity of the student learning experience including:

(1) One comment indicating that the student thought the computer lab and web enabled learning environment provided a "good social environment" (compliment type 6). Perhaps this was a more social tutorial group with students joining in to assist one another (as was noted in the observations reported in Chapter 6).

(2) One comment indicating the student thought the web enabled learning environment for accounting was good for helping to improve computer skills (compliment type 7).

Both of these comments would be worth following up in future research.

Comments dealing with hypotheses regarding the process variables of control, feedback and in-context learning

Compliment types 3 and 4 dealt with feedback and control issues that were covered in the learning survey, and confirm students positive view of the learning effects of control through flexibility and rapid feedback from the on-line tests. There was one comment as well on the student's positive view regarding the on-line dictionary (compliment type 8) that helps confirm evidence from the descriptive statistics earlier in this chapter.

Comments dealing with hypotheses regarding the engagement variables of attitude towards accounting and toward computing

Compliment types 1 and 2 indicate a positive attitude towards the web enabled learning environment supporting the evidence gathered in Chapter 4. Compliment type 5 provides direct support for the positive impact of the web enabled learning environment on attitude towards accounting content. This provides direct support for the outcomes found in Chapter 4 on experimental results.

Formative information for future development

As has been the case in a number of the other qualitative sections reported in Chapter 6, the negative comments (complaints) were largely raising formative issues. These issues include:

- Need to invest sufficient resources into content development to assure consistent quality and need for sufficient training in the learning environment (most frequently mentioned complaint as noted in complaint type 1)
- Desire for more interaction with other students and the tutor, pointing toward the need to incorporate small group and collaborative work with the web enabled environment (second most frequently mentioned complaint as noted in complaint type 2)
- Need to provide better training at the outset of the web enabled sessions (complaint type 3)
- Need to consider different student learning styles and learning preferences (complaint type 4, and 6)
- Need to consider students' background in designing the learning environment so that beginners have more support (scaffolding) until they are up and running (complaint type 5 and 6)
- Need to emphasise flexible delivery and self paced nature of the system so that students don't feel compelled to spend more time than is comfortable for them in a single sitting. Small group and collaborative work could also alleviate the complaints/difficulties noted here (complaint type 7)
- Need to verify that the server hardware and software are performing satisfactorily (complaint type 8)

	Category	No.	Typical comments
1	Compliments	25	Interesting and fun way to learn, enjoyable, wish all classes were this way
2	Compliments	18	Cool, good, very good, I liked it
3	Compliments	17	Great flexibility, can do in my own time
4	Compliments	6	Really liked rapid feedback
5	Compliments	5	Good way to learn accounting
6	Compliments	1	Provided a good social environment
7	Compliments	1	Helpful for improving computer skills
8	Compliments	1	Liked the on-line dictionary
1	Complaints	11	Repetitive tests, more hints, more comprehensive dictionary, errors in material, all requiring more resources in initial development
2	Complaints	9	A bit antisocial, prefer people-to-people, rather have a human
3	Complaints	9	Spreadsheet a bit hard to follow and other navigation issues pointing to the need for better training
4	Complaints	5	Prefer normal class, prefer text book to computer screen,
5	Complaints	5	Hard to learn accounting this way if no prior background in accounting
6	Complaints	4	I am not so good with computers, apprehensive
7	Complaints	4	A bit too rushed, an hour staring at the computer is too long
8	Complaints	1	Sometimes the server was slow

Figure 5-13: Summary of comments from learning survey open question

Summary of survey analysis

This chapter has presented evidence from the learning survey portion of this study. The evidence has represented four different sources: (1) descriptive statistics on the survey items, (2) impact analysis regarding student process variables of control, feedback and in-context learning, and engagement variable of time-on-task, (3) impact of process variables on engagement variables and (4) qualitative data from the open question on the learning survey.

The synthesis of results from the survey data analysis was carried out in line with the objectives of this research study and the related objectives of the various data analysis methods discussed and analysed earlier in this chapter. These included:

- To establish a supporting chain of evidence from which to support or refute the research hypotheses as shown in Figure 5-2
- To gain a broader understanding of student views on the learning process and learning environment, including views on most valuable and most useful features of the web enabled learning environment
- To discover any additional learning factors that were not included in the original research design
- To discover students' opinions on the positives and negatives of the learning experience
- To discover issues arising from the above in support of the formative goals of this research

Figure 5-14 gives an association matrix of the above objectives as they draw from the survey data analysis methods used. Under the source of evidence columns the following guide is used: + = supported, 0 = mixed support, - = not supported. The final column of Figure 5-14 gives a summary of the outcome, showing that the given hypothesis is supported, not supported or mixed support. A synthesis of the information is then presented for each hypothesis and objective.

Hypothesis or other objective	Source of evidence			Summary Of Outcomes
	Descriptive Statistics	Impact Analysis	Open question	
Primary Hypothesis:				
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	+	-	+	Mixed Support
Impact of web course on process variables				
2a (i). Support for higher student control	+	+	+	Supported
2a (ii). Support for improved feedback	+	+	+	Supported
2a (iii). Support for greater in-context learning	+	-	0	Mixed Support
Impact of web course on engagement variables				
2b (i). Better attitude towards course content			+	Supported
2b (ii). Better attitude towards computers			+	Supported
2b (iii). Higher time-on-task	-	-		Not Supported
Impact of process variables on engagement variables				
3a. Process variables affecting better attitude towards course content		-		Not Supported
3b. Process variables affecting better attitude towards computers		-		Not Supported
3c. Process variables affecting higher time-on-task		0		Mixed support
Hypothesis regarding effective learning				
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		-		Not Supported
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning		-		Not Supported
Other objectives				
Most valuable features of web enabled environment	✓			
Discover additional learning factors			✓	
Formative recommendations	✓		✓	

Figure 5-14: Association of hypotheses and other factors with research methods and outcome

The following presents the evidence from the various sources and conclusions regarding that evidence for each of the hypotheses and objectives. The hypotheses comments will often draw comparisons between the treatment and control groups, focusing on the comparative results of the treatment group as better or worse.

Primary Hypothesis:

Hypothesis 1. Web technologies do provide a pedagogically sound foundation for more effective educational systems: The overall hypothesis brings together the individual hypotheses and is tested by the various analyses carried out on the survey data. The overall result is that, in the view of the students, those in the treatment group had a higher sense of control and better feedback, thought that this was a more interesting way to learn accounting, found the web enabled learning environment a better way to learn and spent significantly less time-on-task, yet learned at least as much. Therefore for the student process variables and student engagement variables (see Figure 5-11) this hypothesis is largely supported.

However it could not be demonstrated that the significantly better results on these variables was the direct cause of improved student performance on the post-test results (when controlling for the pre-test results). This issue will be looked at more closely in Chapter 7, Synthesis of results from experimental, survey and qualitative analysis sources. Thus for the impact on learning this hypothesis is not supported.

It should be noted that there was a significant minority of students who did not like the web based environment, demonstrating the variability of student learning styles and learning preferences. See Other Objectives: Formative Recommendations below for further coverage on this.

Further detail from the supporting hypothesis follows.

Impact of web course on process variables

Hypothesis 2a (i). Support for higher student control: The descriptive statistics (Figure 5-4) clearly indicate that students in the treatment group had a greater sense of control over their learning, with especially strong responses regarding flexibility of timing and control over pace of learning. This result is strongly supported by the impact analysis which demonstrated that the treatment had a positive impact on student sense of control, significant at the 1% level (Figure 5-10a). The open question evidence (Figure 5-13) also supports the concept that students in the treatment group had a strong sense of control, commenting frequently on the flexibility and self paced nature of the web enabled learning environment. Overall this hypothesis is supported by the survey portion of this study.

Hypothesis 2a (ii). Support for improved feedback: The descriptive statistics (Figure 5-5) clearly indicate that students in the treatment group believed they enjoyed greater feedback, with especially strong responses regarding rapid feedback from the on-line tests. This result is supported by the impact analysis which demonstrated that the treatment had a positive impact on student sense of feedback, significant at the 1% level (Figure 5-10a). The open question evidence (Figure 5-13) also supports the concept that students in the treatment group appreciated the rapid feedback received from the on-line tests. Overall this hypothesis is supported by the survey portion of this study.

Hypothesis 2a (iii). Support for greater in-context learning: The descriptive statistics (Figure 5-6) indicate that students in the treatment group believed they enjoyed a more cohesive, in-context learning environment, with strong responses regarding the excel spreadsheet exercises, the on-line dictionary and hints provided for the on-line tests. This result is however not supported by the impact analysis which demonstrated that the treatment had a non-significant impact on student sense of the in-context learning environment (Figure 5-10a). The open question evidence (Figure 5-13) supports the weak nature of this student process variable, with only one student making any direct positive comments about the in-context issues (one comment on the on-line dictionary). Overall this hypothesis has mixed support from the survey portion of this study.

Impact of web course on engagement variables

Hypothesis 2b (i). Better attitude towards course content: The open question on the learning survey (Figure 5-13) provided evidence that a number of students saw the web enabled learning environment as a better way to learn accounting. Thus this hypothesis is supported by the survey portion of this study.

Hypothesis 2b (ii). Better attitude towards computers: The open question on the learning survey (Figure 5-13) provided strong evidence that the majority of students saw the web enabled learning environment as a better way to learn, finding it interesting and fun. There was however a significant minority who did not share this view and preferred the human touch. Overall this hypothesis is supported by the survey portion of this study.

Hypothesis 2b (iii). Higher time-on-task: The descriptive statistics (Figure 5-7) indicate that students in the control group spent an average of 6.27 hours in preparing for and attending the three tutorials while the treatment group spent an average of 4.01. This appears to be a significant difference and this result is supported by the impact analysis that shows that the impact on time-on-task of being in the treatment group was significant at the 1% level (Figure 5-10b). Thus this hypothesis is not supported by the survey portion of this study, but instead the converse appears to be the case.

Hypothesis 3: Impact of process variables on engagement variables

The impact analysis summarised in Figure 5-10c shows the effect of the process variables on the engagement variables. This analysis demonstrates that the process variable of control over the learning environment has a significant impact (at the 10% level) on the engagement variable of time-on-task (see Figure 5-10c). The remainder of the process variables appear to have no significant effect upon any of the engagement variables. This demonstrates that the process variables have little indirect impact on student learning further supporting the findings from hypothesis 2a (i), 2a (ii) and 2a (iii) that the process variables have no significant direct impact on student learning.

Hypotheses regarding effective learning

Hypothesis 4a. Student process impact on student learning: In conjunction with the impact analysis on Hypotheses 2a (i), 2a (ii) and 2a (iii) above, it was found that students did not perform better on the post-test as a result of greater support for control, feedback and in-context learning. This may be seen in Figures 5-10d and 5-11 which show a significant negative impact of Feedback on Bloom's Low (10% significance level), but no significant impact for any of the other process variables on student learning. Thus this hypothesis is not supported by the survey portion of this study.

Hypothesis 4b. Student engagement impact on student learning: The time-on-task engagement variable was measured in the learning survey and in conjunction with the impact analysis it was found that students in the treatment group spent significantly less time-on-task (see Hypothesis 2b (iii) above). Also time spent in study has a weak positive impact on learning when controlling for treatment (non-significant, Figure 5-10e). Overall, students learn somewhat better in the treatment group, having spent significantly less time, thus appearing to have an efficiency impact. This outcome is contrary to the posited theory, and should be examined more closely in future research.

Other objectives

Most valuable features of web enabled environment: One of the objectives of this study is formative in nature, supporting future initiatives in improving web enabled learning environments. In line with that objective, this study also wished to gain an insight on which features students found most valuable in the web enabled learning environment. Based on the descriptive statistics section (Figure 5-8) of this chapter, these most valuable features were: the flexibility of timing and accessibility to material that the web enables, the rapid automated feedback supported by the on-line tests and the ability to control the pace of learning. In addition to these top features a number of other features were highly ranked including: the interactive spreadsheet exercises, the on-line dictionary, overall better control of the environment, and support for in-context learning with hints on tests and scenario based learning.

Discover additional learning factors: In line with the formative objective of this study, it was the intention to attempt to discover additional learning factors not being tested by this study. The qualitative data gathered from the open question on the survey (Figure 5-13) assisted with this. Additional learning factors discovered as a result included: the on-going need of many students for the human touch, the need for collaborative learning environments, and the need to emphasise the acquisition of computer skills within the context of life long learning skills and learning other disciplines. Given the demands of the modern corporate work environment this could be a strong effectiveness benefit of the web enabled learning environment.

Formative recommendations: Additional formative recommendations that can be made based on the descriptive statistics (Figure 5-7) and open question comments (Figure 5-13) from the survey include:

- Additional research be carried out on the time-on-task issue to discover more about the efficiency issues highlighted by the evidence not supporting Hypothesis 3c: Higher time-on-task.

- Further research be carried out on flexible learning application of web enabled learning environments where the entire course (not just tutorials as in this study) is undertaken in this environment.

- Further research be carried out on the design of web enabled flexible learning systems incorporating collaborative learning features.

- The need for sufficient resources to be invested in web enabled learning environments to assure the overall quality of the systems.

- The need to provide sufficient training to both students and tutors at the outset of use of new web enabled learning systems, including appropriate use of self paced techniques. This training should be tailored to the background of tutors and students to bring them up to a satisfactory level of competence in navigation and use of the system.

- Need to consider different student learning styles and learning preferences.

- Need to verify that server hardware and software are performing satisfactorily.

Conclusion

This chapter has presented the survey portion of this study including the design, implementation and results. The design section included the objectives of this portion of the study together with the procedures used in administering the survey as well as the process followed in constructing the survey. Descriptive statistics for the survey were given together with an analysis of the best features of the web enabled environment from the students' viewpoint. The reliability of the instrument was then assessed followed by an impact analysis.

The overall result is that in the view of the students, those in the treatment group had a higher sense of control and better feedback, thought that this was a more interesting way to learn accounting, found the web enabled learning environment a better way to learn and spent significantly less time-on-task, yet learned at least as much. Therefor for the student process variables and student engagement variables these hypotheses were largely supported. However it could not be demonstrated that the significantly better results on these variables was the direct cause of improved student performance on the post-test results (when controlling for the pre-test results). This issue will be looked at more closely in Chapter 7, Synthesis of results from experimental, survey and qualitative analysis sources. Thus for the impact on learning this hypothesis is not supported. It should be noted that there was a significant minority of students who did not like the web based environment, demonstrating the variability of student learning styles and learning preferences.

The major formative recommendations from this portion of the study include: (1) need for more research on the efficiency issue raised by the evidence showing that time-on-task was significantly less for the treatment group, contrary to Hypothesis 3c; (2) the need for further research on such web enabled environments incorporating the whole course rather than just part of the course. Formative outcomes from this chapter will also add to the qualitative data and formative outcomes of the following chapter covering the major qualitative aspects of this study, including the design of the qualitative work, data gathering and analysis of the field-work.

Chapter 6: Analysis of Qualitative Data

Introduction

The gathering of qualitative data and its analysis is central to the overall case research method being employed in this study. The complex nature of real learning environments demands a more holistic approach to research on the interaction of technology, learning methods, students' perceptions and their environment.

This qualitative data permits analysis of the learning phenomenon as a contemporary event in its rich, real world context, while at the same time supporting our understanding about the nature of the relationships. In addition the qualitative methods employed support the formative goals of the study, allowing insights into why certain features of the learning environment worked well or poorly and providing direction for improving future learning systems. Experimental and survey methods were employed in Chapters 4 and 5 to help establish the inter-relationships in the learning environment and further enrich the in-depth understanding of the learning phenomenon.

This chapter is organised as follows:

- ➢ Review of the research model and implications for the qualitative design
- ➢ Description of the objectives, the qualitative procedures carried out and the data gathered from each of the methods used, including:
  - ♦ Observation: weekly observation of two tutorials over the three weeks of the case study experiment
  - ♦ Interviews: weekly interviews with five individual students
  - ♦ Focus group meetings
  - ♦ Summary of email comments from students to their tutors
  - ♦ Follow up interviews with best and worst performers

➤ A synthesis of the qualitative data and assessment in the light of the research model and hypotheses

This section describes the design, conduct and outcomes of this qualitative data gathering.

Review of the research model and implications for qualitative design

The research design developed in Chapter 3 provided a series of testable hypotheses, a research model to test them and a multi-method research process to operationalise the model. In addition the choice of method made it clear that the research design should provide formative evidence and advice as one of the outcomes of the study. Because of the need to study the learning process in its real world context an overall case study method was chosen, supported by experimental and survey components to the research. The research model can be seen in Figure 6-1.

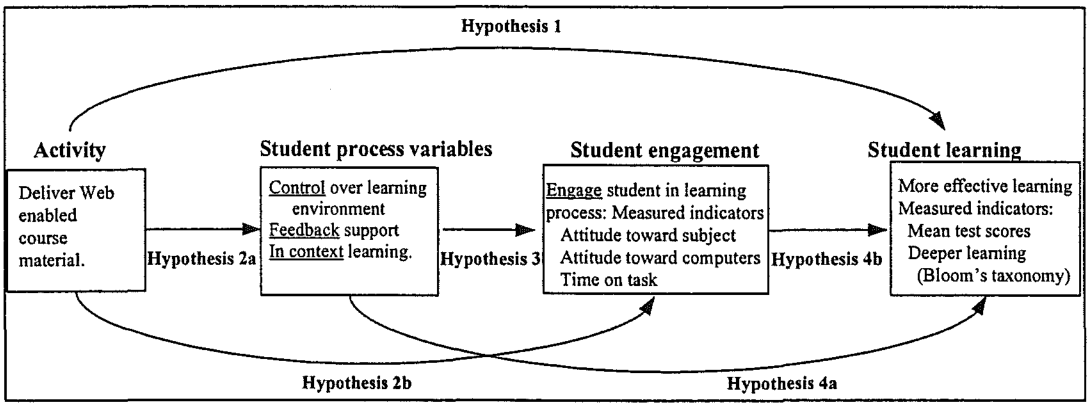

Figure 6-1: Research model (from Figure 3-1)

Figure 6-1 is supported by Figure 6-2 which lays out the testable hypotheses and the research methods that will supply evidence regarding those hypotheses.

Hypothesis	Research Methods used		
	Exper. Ch. 4	**Survey** Ch. 5	**Qualit.** Ch. 6
Primary:			
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	✓	✓	✓
Impact of web course on process variables			
2a (i). Support for higher student control		✓	✓
2a (ii). Support for improved feedback		✓	✓
2a (iii). Support for greater in-context learning		✓	✓
Impact of web course on engagement variables			
2b (i). Better attitude towards course content	✓	✓	✓
2b (ii). Better attitude towards computers	✓	✓	✓
2b (iii). Higher time-on-task		✓	
Impact of process variables on engagement variables			
3a. Process variables affecting better attitude towards course content		✓	
3b. Process variables affecting better attitude towards computers		✓	
3c. Process variables affecting higher time-on-task		✓	
Regarding effective learning			
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		✓	✓
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning	✓	✓	✓

Figure 6-2: Association of hypotheses with research methods (from Figure 3-10)

In addition to gathering data to test the various hypotheses given in Figure 6-2, the qualitative portion of this research also supports the following objectives of the research:

- To verify that the activities of the research as designed were carried out and discover any unplanned activities that may have been used

- To discover any additional learning factors that were not included in the original research design

- To gain a view of students' opinions on the positives and negatives of the learning experience

- To develop recommendations in support of the formative goals of this research

Qualitative objectives, procedures and outcomes

Each of the following sections describes the objectives of the qualitative method used and the procedures that were followed in carrying out each of the qualitative data gathering methods. Each section then describes the outcomes from the method in line with the objectives. Because the qualitative methods differ considerably from one another various forms of reporting are used for the outcomes. In each section the outcomes are reported in reference to the objectives for each method. A summary and synthesis of the results from all methods is provided at the end of the chapter to demonstrate the support for the hypothesis and objectives of the chapter as a whole.

Tutorial Observations

Observation of tutorials in which the web enabled learning environment was being used gave the researcher an opportunity to view the learning environment first hand, seeing the students interacting with the system, asking questions of the tutor or of other students. This section establishes the objectives of this research process as well as the procedures followed and a summary of the outcomes from the observations.

Objectives

The objectives of the observations were:

1. To observe the interaction of the students with the learning system and capture first hand data on student experience with the system as part of the

process of testing the hypotheses of this research dealing with the process variables of control, feedback and in-context learning.

2. To verify that the activities, as designed, are actually carried out and whether any additional (extraneous) activities were carried out.

3. To discover additional learning factors that were not included in the original research design.

4. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. A total of 30 tutorials groups were involved in the overall experiment/case study. Of these 15 were assigned to the treatment group, randomly selected from the 30, with the remaining 15 included in the control group.

2. Two tutorials were selected for observation from among the 15 tutorials that were randomly selected for inclusion in the treatment group. These two tutorials were selected from two different days, one from the morning and one from the afternoon and for two different tutors.

3. Weekly observations of these two tutorials were conducted during the three weeks over which the tutorials ran.

4. The researcher entered the tutorial at the beginning of the session and took a seat at a computer at the rear of the computer lab during the start-up phase of the tutorial (while students were arriving, logging-in, roll being taken etc.). The researcher maintained a passive role, leaving the tutor to conduct the session in the normal fashion.

5. Observations of the treatment group were conducted to see students' reaction to the treatment, the purpose being to discover why the treatment worked (or didn't work) and to verify the administration of the treatment. The same two tutorials were observed each week.

Summary of outcomes

The following summary of the observations is organised in line with hypotheses of this research and the objectives of this section. Supporting evidence is drawn from the tutorial observations, as shown in Appendix C. In this summary the following parenthetical abbreviations are used to indicate relation to particular hypothesis or objectives: Hypothesis 2a: C=Control, F=feedback, I=in-context; VA=verify activities, LF=learning factors; P=positive, N=negative, Form=formative.

Appendix C gives the full comments recorded during the observations.

In summary, the outcomes from the observations were:

In regard to hypotheses dealing with the process variables of control, feedback and in-context learning:

It appeared that students were using the web enabled learning aids designed to give control (C), improve feedback (F) and enhance in-context learning (I) (including on-line tests, Excel spreadsheets, hints, on-line dictionary and examples). It appeared, however, that there was limited use of the textbook references (I). Students appeared to be engaging well with the learning system and getting on with the work (P).

There appeared to be very little use of the email and discussion group features, largely due to the lab environment, in which a student could simply put their hand up and the tutor would respond to the question directly (F). This could limit some of the expected feedback benefits anticipated from the use of these features. It is presumed that this would differ considerably in a distance learning setting (Form).

Verification that the activities, as designed, were actually carried out:

Student activities, as designed, were largely carried out (VA). However it was noted that some students had difficulty in dealing with the proper navigation of the supporting Excel spreadsheets in the first week (VA, C, N). This problem was largely overcome by week two as a result of discussion group postings and direct tutor assistance in the lab (Form).

There was some confusion during the first week over navigation and the order in which content should be done (VA, C, N). This "learning curve" problem was largely overcome during the first session, but provision of a specific training session would be very beneficial (Form). This was not done due to the cramped time schedule for this course and the size of the class.

As noted above, there appeared to be very little use of the email and discussion group features (VA). This was noted during week one and as a result all students were encouraged by tutors during the following week to make use of this system and submit comments and questions to their tutors (Form). Some students did follow through with this, and the email section of this chapter describes the comments from students (Form).

Performance of the system, including loading of Excel spreadsheets, delivering and marking of tests, seemed to be satisfactory with 2-3 second response times for delivery of content pages and 8-10 second response times to load Excel and return marked test feedback from the TopClass database (VA).

The number of students present in the observed sessions varied from 12 to 19 (VA).

During week two some students received an error message while logging into the TopClass system, indicating that there were too many users accessing the system at one time. A 25 user licence was being used, and obviously some students were accessing the system from outside the tutorial. The researcher had an assistant go around to the other four labs nearby and ask students to log off, if using this TopClass course. A 50 user license was organised and upgraded before the end of the week (VA), which resolved the difficulty.

Discover additional learning factors or extraneous activities

It was noted by the researcher that some students provided spontaneous assistance to one-another in the lab when the tutor was busy (LF). This seemed to build rapport between the students. Additional research should be done in the area of providing support for group learning processes in both the lab/small group setting as well as in the web enabled course content. This appeared to be the only significant extraneous activity pointing toward an additional learning factor.

Interviews

Weekly interviews with individual students over the period of the special web enabled tutorials were designed to give the researcher a view as to the personal experience of individual students with the learning system. This more in-depth view was expected to yield insights into the system that could not be gained by observation, survey or other group processes. This section establishes the objectives of this research process as well as the procedures followed and a summary of the outcomes from the interviews.

Objectives

The objectives of the interviews were:

1. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the process variables of control, feedback and in-context learning.

2. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the engagement variables of attitude towards accounting and toward computing.

3. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. A group of individual students from each of the two tutorials to be observed were identified as potential interviewees. They were selected from the tutorial class list

with the intention of yielding a group of interviewees that represented a balance of backgrounds. Selection was made on the basis of demographic information provided on the pre-test (taken prior to beginning the tutorial series). The criteria used included: gender, ethnicity, age, prior accounting background and prior computing background. The accounting and computing scores were based on student self report on a scale of 1-6, with 1 lowest and 6 highest. These criteria were chosen to provide as broad a perspective on personal experience of the learning system as possible.

2. Toward the end of the first observation session the researcher approached three individual students from each tutorial to request their participation in one-on-one interviews. If a student declined to participate the first backup was approached, and so on until three students from each of the two tutorials being observed agreed to participate in the series of interviews. Although six agreed to participate in the interviews, one student changed her mind and ultimately did not participate, due to language difficulties.

3. Each interviewee was asked to attend a weekly 20-30 minute interview a day or two following the actual tutorial. A specific appointment time was negotiated with each student. The student was told the reason for the interviews was to gain insights from their personal experience of the web enabled course material and to discover what they believe worked well or poorly.

4. The interviews were conducted weekly during the three weeks of the case study experiment by the researcher.

5. At the interviews the interviewees were asked if they would permit the session to be audio taped, and then they were asked a series of largely open questions (see below for more detail on each interview session).

6. The next appointment time was negotiated with each student at the end of each interview.

7. Interview one consisted of a set of screening questions and questions about a student's initial impressions on the AFIS On-line learning system. (See Appendix E and E-1)

8. Interview two focused on issues related to the three primary student process variables: control, feedback and in-context learning. At the close of this interview students were asked to complete a journal (See Appendix E-3) over the next week to capture any key factors, questions and experiences with the AFIS On-line learning system. (See Appendix E-2)

9. Interview three reviewed students' journal comments and questions and provided an opportunity to clarify student responses on the learning survey completed in the final tutorial of the series. (See Appendix E-3, E-4, and D)

Summary of outcomes

The characteristics of the five students participating in the interviews were as follows:

Student	Computing (scale: 1-6)	Accounting (scale: 1-6)	Sex	Age	Ethnicity
1	5	4	M	20-25	European
2	6	3	M	17-19	European
3	1	1	F	20-25	Asian
4	2	5	F	17-19	European
5	1	4	M	17-19	Asian

Figure 6-3: Demographics of interviewees

The following summary of the interviews is organised in line with hypotheses of this research and the objectives of this section. Appendix C gives the full comments recorded during the interviews. In this summary the following parenthetical abbreviations are used to indicate relation to particular hypothesis or objectives: Hypothesis 2a: C=control, F=feedback, I=in-context; Hypothesis 2b: AA=attitude towards accounting, AC=attitude towards computing; P=positive, N=negative, Form=formative.

In summary, the outcomes from the interviews were:

In regard to hypotheses dealing with the process variables of control, feedback and in-context learning:

Student opinions varied during the first week. Those with some background in accounting felt that the AFIS On-line system was excellent (AC, P), especially liking the anytime/anywhere availability of the system (C, P). However students with little or no background found that there wasn't always quite enough help (F, N). For example, the Hint button on the test questions sometimes didn't give enough of a hint with some hints being excellent and others not so useful (F, N). This issue of consistency of quality of the material appeared a number of times (Form, N). Trying to learn the accounting and at the same time the computing was particularly frustrating during the first week for these less experienced students (AA, N). However as the less experienced students used the system over the next few weeks, most of this frustration and confusion waned (Form).

All of the students interviewed really liked the instant feedback from the on-line tests, together with some explanation on where they went wrong, and the opportunity to do another test covering the same material (F, P). However some felt that more explanation of where they went wrong, or access to the hint button at this point would be particularly beneficial (F, N, Form).

The comment came from a couple of students that they really liked the self-paced nature of the system, with students of all capabilities being able to spend as much time as needed to learn the content (C, P). This was especially felt to be beneficial to the students with English as a second language (Form).

Most of the interviewees particularly liked the integrated spreadsheet exercises and the immediate feedback provided (I, F, P). However a few felt that navigation in the spreadsheet was somewhat confusing and better explanations should be given for the answer (C, F, N). Part of the solution to this is to provide more training in the first session, including navigation and editing within Excel (Form).

It was generally expressed that the various pieces of the system held together well and were useful with the scenarios, tests, hints, spreadsheets and other resources providing a coherent learning experience (I, P). It was also generally felt that the on-line dictionary was very good, but with some inconsistencies (I, P). However, it was expressed that for the total novice there might not be enough information at the lowest level (F, C, N). Many were unaware that the textbook references were included (Form, N). This piece of information alleviated this concern to a considerable extent for the interviewees, but indicates the need to make the textbook references more accessible (Form).

In regard to hypotheses dealing with the engagement variables of attitude towards accounting and toward computing:

As noted above, those with some background in accounting felt that the AFIS On-line system was excellent (AC, P), especially liking the anytime/anywhere availability of the system (C, P).

As noted above, trying to learn the accounting and at the same time the computing was particularly frustrating during the first week for the less experienced students (AA, N).

Formative information for future development

A couple of the students commented that they liked having the tutor in the room as they could ask them for help, however they found it frustrating having to wait for the tutor when the tutor was busy with another student (N, Form).

A few of the students commented that they liked the objectives and suggested timings at the beginning of the episodes (Form, C, P). They also liked the idea of the discussion list and email, although they didn't use it (F, P, Form). A number felt that mixing the web enabled system with small group (face-to-face) discussions would provide the best of both worlds (Form).

One of the international students felt that the dictionary was pitched a bit too high for those who did not have English as their first language (Form, I, N).

Focus group meetings

Of the 15 tutorials in the treatment group, 2 tutorials were chosen for weekly observation over the three weeks of the experiment. In addition it was desirable to gain feedback from students in the other treatment tutorials. Focus group meetings were conducted with students from these other treatment group tutorials to learn their perceptions of the on-line learning process, and to discover their attitudes and insights to further enrich the depth of the research. A selection of 2-3 students was chosen from each of these 13 treatment tutorials to participate in a focus group meeting. The aim was to have two groups with 10-15 students in each group.

Objectives

The objectives of the focus group sessions included:

1. To gain insights from students first hand experience of the learning system, including positive and negative aspects of their experience.
2. To confirm the nature of the three process variables (control, feedback, in-context) used in the learning survey (with all students) by having participants in the focus groups categorise the various positive and negative issues they raised.
3. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. There were a total of 15 tutorial groups in the Treatment group. Two tutorials were observed and a selection of students interviewed as noted above. Additionally 30 students were selected from the remaining 13 treatment tutorial groups to participate in two focus group meetings.

2. Two to three individual students from each of the thirteen tutorials were identified as potential participants. They were selected from the tutorial class list with the intention of yielding a group of interviewees that represented a balance of backgrounds. Selection was made on the same basis as those chosen for individual interviews using demographic information provided on the pre-test (taken prior to beginning the tutorial series. This included five criteria: accounting background, computing background, sex, age and ethnicity.

3. The students were invited to participate in a short (30-40 minute) group discussion on the learning that took place in the AFIS On-line tutorials.

4. Upon accepting the invitation the students were assigned to one of the two focus groups in such a way as to maintain the balance of gender, ethnicity, age, prior accounting background and prior computing background.

5. Each of the two focus groups met with a facilitator. One group was facilitated by the researcher, the second group by a facilitator from the University's Educational Research and Advisory Unit.

6. The facilitator carried out the following group process:

7. Brainstormed the best/most useful factors/features of the AFIS On-line learning system, writing these on the whiteboard. After brainstorming was complete, discussed items with students to verify their understanding and to consolidate similar items. An associate captured the same items onto a computer connected to the departmental LAN. This computerised list was later used by students for multi-voting and categorisation. This process assisted in mitigating the internal validity issue of student peer pressure affecting individual student voting patterns.

8. Brainstormed the worst/most confusing, most needing improvement features of the AFIS On-line learning system, writing these on the whiteboard. After brainstorming was complete, discussed items with students to verify their understanding and to consolidate similar items. An associate captured the same items onto a computer connected to the departmental LAN. This computerised list was later used by students for multi-voting and categorisation.

9. The lists of brainstormed items were then printed out via the departmental LAN, and a secretary photocopied sufficient copies for students to use in the multi-voting process, bringing them to the room where the focus group meeting was being held. A sample of this document (without any items) may be seen in Appendix F.

10. Carried out a multi-voting process on each list to rank order them. Students were given a printed copy of the list to vote on. Students were instructed to vote for their top Most Important (or Worst, Most Confusing, Most Needing Improvement) items. See instructions on Appendix F.

11. Categorisation: carried out a categorisation process to determine which items were related to each other by first discussing the categories: F (feedback), C (control), I (in-context learning) or O (other) so students were clear on what they meant. Then students used the same sheets as for item (10) above (see Appendix F for a sample).

Summary of outcomes

There were two focus groups. Focus group one had 12 participants while group 2 had 8 participants. Although 30 students were invited to attend a focus group, 15 in each group, not all students attended the focus group. The participation rates were typical of first year student attendance at lectures and tutorials, which average approximately 65% (based on University statistics). The two focus groups had 80% and 53% participation rates respectively. The following summary of the focus group meetings is organised in line with the hypotheses of this research and the objectives of this section. Appendix F provides a sample of the instructions and voting sheet used in the multi-voting process and Appendix F-1 provides a detailed spreadsheet from which Figure 6-4 was derived.

Positives and negatives of students' experience with learning system

Figure 6-4 shows the positive and negative comments of the two focus group sessions. Also shown is the percentage of participants who felt a particular comment was very important (using the multi-voting technique noted in procedure 10 above).

In the positive section of Figure 6-4 both focus groups came up with many of the same comments, including all of the top four: quick feedback on tests, dictionary and hint/help button, flexible timing, and excel spreadsheets. These comments largely confirm comments from the interviews.

In the negative section of Figure 6-4 there was less commonality of response and more confusion over the categorisation of the criticisms. The primary areas needing improvement support the comments from the interviews. These comments included: needing more information when you gave a wrong answer, not enough explanation for spreadsheet answers, some errors and inconsistent quality in the tests, and having a pointer on the menu to indicate what you have covered and where you are up to.

Categorisation by process variables of control, feedback and in-context

Figure 6-4 also shows the category(s) into which students from each focus group believed the various positive and negative comments belonged (C=control; F=feedback; I=In-context learning; O=Other). The categorisation of the positive comments was generally quite consistent with both focus groups categorising the comments in a similar fashion. These comments also were categorised in a similar way on the learning survey, as shown in the final column. This provides additional support for the structure of the learning survey used with all students and discussed in Chapter 5. This learning survey centred around the three process variables of control, feedback and in-context. Not all student comments related to items on the learning survey, in particular the negative comments were largely related to formative issues rather than to control, feedback or in-context learning.

The categorisation of the negative comments showed less commonality of response than the positive comments, and more confusion over the categorisation of the criticisms. This is unsurprising as the criticisms were typically formative in nature and not really related to issues of control, feedback or in-context learning.

Formative information for future development

From the positives and negatives highlighted in Figure 6-4 the following summary of formative information can be distilled:

- Sufficient resources need to be invested in content development to assure the consistent quality of the learning system.

- A balance needs to be struck between providing sufficient feedback and not making it too easy for students. This probably requires multiple levels of feedback tied to a diagnostic system that would dynamically establish the student's level of competence and provide a suitable level of feedback. This would require development of "intelligent tutor" features more sophisticated than those used in this research.

- Navigational and progress feedback needs to be self evident so students know what progress they have made during the multiple sessions.

- Sufficient training on the use of the system must be provided at the outset so that students get the maximum out of the learning system without the frustration of having to learn the navigation, feedback and other operational mechanisms at the same time. This also points to a standard system and interface for an entire campus.

- Learning aids (dictionary, help, text references etc.) should be available at all times, without having to navigate to a separate page.

Type	*Comments*	*Grp. 1*	*Cat.*	*Grp. 2*	*Cat.*	*Surv Cat.*
Pos	Quick test results	92%	F	50%	F	F
Pos	Dictionary and hint/help button (joint response)	67%	F/I	63%	I	I
Pos	Flexible timing/24 hour availability	67%	C	38%	C	C
Pos	Excel spreadsheets	58%	I/F	38%	I/F	I
Pos	Scenario/scene setting	33%	I/F	-		I
Pos	Textbook references	25%	I	25%	I	I
Pos	Tests similar but sufficiently different	25%	I	-		-
Pos	All the information required was available	17%	I/F	-		-
Pos	Flexible location (from home or on campus)	8%	C	25%	C	C
Pos	Not a lot of paperwork	8%	O	-		-
Pos	Questions go back to basics	-		38%	I/O/F	-

Pos	Practical examples	-		25%	I	I
Neg	Not enough information to understand if you gave wrong answer	83%	F	-		
Neg	Not enough explanation for spreadsheet answers	75%	F	25%	C/F/I/O	
Neg	Some errors in tests	42%	I/F/O	-		
Neg	A pointer on to next section or indication of what has been covered already	42%	F/C/I	17%	C/I	
Neg	Navigation in message system	33%	F/C/O	8%	C	
Neg	Some test questions a bit vague	33%	I/F/O	-		
Neg	Introduction/training for system inadequate	25%	I/F/O	-		
Neg	Seemed to be testing computer skills, need more training	25%	I/O/F	-		
Neg	Access to dictionary, etc for spreadsheet answers	25%	F/I	-		
Neg	Too high level if never done account	17%	I/C/O	-		
Neg	Spreadsheet #4 has an error for accrued expenses	0%	I/F	-		
Neg	Unable to save answers on tests	-		17%	C	
Neg	Can't start where you left off	-		25%	C	
Neg	Test question repeated/too easy on second and third test	-		25%	I/F	

Figure 6-4: Summary of two focus group meetings

Summary of email comments

Students in the treatment group were asked to email their tutors with questions as well as positive or negative comments regarding the web enabled learning environment they were using. There were a total of 46 emails received during the time of the study, with some emails including more than one positive or negative comment. The comments from these emails are summarised in Figure 6-5, with the details of the emails included in Appendix G.

Objectives

The objectives of collecting and summarising email comments included:

1. To gain insights from students' first hand experience of the learning system, including positive and negative aspects of their experience.

2. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the process variables of control, feedback and in-context learning.

3. To gain a view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the engagement variables of attitude towards accounting and toward computing.

4. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. Students were encouraged to use email in communicating with their tutors.

2. This email was captured in an archive and analysed to enrich the qualitative data of this research.

3. The archive of email was analysed and categorised for common themes.

Summary of outcomes

Figure 6-5 contains a summary of student comments given within the emails sent to tutors during the series of tutorials. The email comments were categorised into: **compliments**, **complaints**, requests for **help** and requests for **guidance**. Detailed comments from the emails are included in Appendix G. The figure is organised with the first and second column showing the type of comment (compliment 1 to 8 or complaint 1 to 9), with the third column indicating the number of times this type of comment was made. The final column provides indicative comments that fell into this category. These comments are discussed below in connection with the objectives of this qualitative method noted earlier and should be read in conjunction with Figure 6-5.

Positives and negatives of students' experience with learning system

The positive and negative comments from students' emails dealt largely with issues covered below regarding the hypotheses of this study and formative comments. Overall, compliments outweighed complaints by 41 to 27 (there was more than one type of comment per email), and the feedback from this source was valuable in validating the data gathered from other sources noted earlier.

Comments dealing with hypotheses regarding the process variables of control, feedback and in-context learning

Compliment types 2 and 3 dealt with feedback and control issues that were also covered in the learning survey (see Chapter 5 for survey analysis). Compliment types 5 and 6 dealt with issues of in-context learning. If the number of comments is indicative of importance, then these comments demonstrate that students felt that issues of feedback and control were more important (18 comments) than issues of in-context learning (4 comments).

Comments dealing with hypotheses regarding the engagement variables of attitude towards accounting and toward computing

Compliment type 4 in Figure 6-5 attributes a positive attitude towards the accounting content as a result of the web enabled learning environment.

Formative information for future development

As has been the case in a number of the other qualitative sections reported earlier, the negative comments (complaints) were largely raising formative issues. These issues include:

- Desire for more interaction with other students and the tutor, pointing toward the need to incorporate small group work with the web enabled environment (most frequently mentioned complaint as noted in complaint type 1)

- Need to invest sufficient resources into content to assure consistent quality. (complaint type 2 and 5, help type 1 and 2)

- Need for sufficient training in the learning environment (complaint type 3, compliment type 1 and guidance type 1)
- Need to balance level of difficulty based on student background (complaint type 4 and 6)
- Making sure that all learning resources are available at all times (complaint type 5 and 9)

	Category	**No.**	**Description**
1	Compliment	9	Overall good, enjoyed the tutorials, once familiar with the program
2	Compliment	9	Really liked immediate feedback on tests, find out what I know and don't know
3	Compliment	9	Loved going at own pace, didn't have to cart books around out of tut times
4	Compliment	8	Invigorating and stimulating way to learn, most effective. Fun to "play around" at own discretion, new and exciting, very interesting way to learn uninteresting material
5	Compliment	2	Liked case situation of running own business like real life, own lifestyle
6	Compliment	2	Hints were good, help but not too much!
7	Compliment	1	Easy to follow
8	Compliment	1	Help from tutors and classmates
1	Complaint	7	Discussion tuts would be better, no discussion between class
2	Complaint	5	Mistake in excel spreadsheet, mistake in test, mistake in dictionary
3	Complaint	5	Navigating and inputting to spreadsheet a problem, can't pick up where you left off last tut, need more instruction

4	Complaint	3	Too easy overall, too easy to be lazy
5	Complaint	2	Dictionary doesn't have all words from tests, dictionary is not available all the time
6	Complaint	2	Hints not that helpful, better hints needed
7	Complaint	1	Quicker help from tutor, waiting for tutor to answer Qs
8	Complaint	1	Fill-in would be better than multi-choice for University
9	Complaint	1	On-line text references should be easier to get to
1	Help	1	Error in one question in test, how do we handle it?
2	Help	1	Terms like: transposition, slides and nominal accounts not in dictionary, please help.
1	Guidance	1	Regarding navigation of TopClass.
2	Guidance	1	If finished with all four episodes is it necessary to come to tuts?

Figure 6-5: Summary of email from students to tutors

Follow up interviews with best and worst performers

Follow up interviews were arranged 10 months after the research was conducted with six students. Students were selected from the best performers and worst performers in terms of improvement in scores from the pre-test to the post-test, from both the treatment and control groups.

Objectives

The objectives of conducting the follow up interviews included:

1. To gain insights from students as to what most contributed to the students performance (positive or negative) including events and circumstances external to the course and the University, including study style.

2. To gain a longer term view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the process variables of control and feedback.

3. To gain a longer term view on individual student's experience with the system as part of the process of testing the hypotheses of this research dealing with the engagement variables of attitude towards accounting and toward computing

4. To gain formative information to assist in improving the learning system for future studies and coursework designs.

Procedures followed

1. A review of best and worst performers on the pre-test/post-test was conducted by analysing improvement scores. The best and worst improved students were invited for interviews. A target of 3 students in the best and 3 in the worst categories was set, including a mix of sex, ethnicity, control group and treatment group.

2. Students agreeing to attend an interview (30 minutes in length) were asked a series of open questions aimed at discovering the internal and external issues that were affecting their performance at the time. Questions were also asked on their perceptions of control and feedback and the affect this had on their learning. See Appendix H for interview questions.

Summary of outcomes

Figure 6-6 shows details on the individual students that agreed to attend a follow up interview 10 months after the intervention. Included are the improvement scores which represent the increase or decrease from the pre-test to the post-test, expressed as a decimal fraction of 1.00. For example student one improved her score on both the Bloom's Low and Bloom's High questions dramatically, while student two saw a very small increase in the Low questions and a decrease in the High questions. Also indicated in Figure 6-6 are sex, ethnicity and whether the student was in the treatment or control group.

A third student from the treatment group agreed to attend a follow up interview, but did not show up for the interview and when contacted said she would prefer to not attend.

Interviewee	Sex	Ethnicity	Bloom Low Dif	Bloom High Dif	Treatment/Control
Student one	F	Other	0.417	0.417	Treatment
Student two	M	European	0.083	-0.167	Control
Student three	M	Asian	0.083	-0.167	Control
Student four	F	European	0.500	0.333	Control
Student five	M	European	0.084	0.500	Control
Student six	M	Asian	0.083	-0.167	Treatment

Figure 6-6: Follow up Interviewee details

Figure 6-7 provides a summary of the interviews conducted with these students, and is organised to show the student identity, control or treatment group (C or T) and if the student was among the best or worst performers (B or W). The material in the final two columns must be read in the context of whether the student was in the control group (face-to-face discussion tutorials) or in the treatment group (web enabled computer tutorials).

It should be noted that of the three process variables being tested (control, feedback and in-context learning) in-context learning was not covered in these interviews. This was because by this point in the research (10 months after the course material had been covered), much of the data analysis had been completed and it was evident that this variable was not significant (see Ch. 4 and 5 outcomes).

The outcomes of these follow up interviews are summarised below in line with the objectives of this section. It must be kept in mind that the material shown in Figure 6-7 includes comments from students who were in the control group or in the treatment group and so the environment they are commenting on will vary. As a result this section of the qualitative data analysis is somewhat different from the earlier sections of this chapter which dealt exclusively with students who were in the treatment group.

Circumstance contributing to students good or poor performance

Figure 6-7 shows that both of the good performers (students one and four) studied with a partner, while the poor performers studied solo (where they mentioned this factor) except student five. Student two commented that his very poor performance was largely due to the fact that his wife had a baby during that time and both mother and child were ill following the birth. Student three expressed some difficulty with English, having to take a very long time to read textbook chapters and finding it hard to understand. A number of students admitted taking on too much, being overconfident or enjoying their freedom too much and these aspects negatively affected their performance.

There were a range of opinions on the quality of the tutoring and lecturing in the course, depending on the student's experience, which tutor they had and what their learning style might be. Also level of interest in the material was mentioned as a success factor. Where they found the material boring, it was harder to learn the material satisfactorily.

Comments dealing with hypotheses regarding the process variables of control and feedback

Regarding control: student one liked the ability to control her pace and have anytime, anywhere access to the material. Student six commented that control was ok, but that he really preferred face-to-face discussion. Regarding feedback: student one and six liked the on-line tests, but student one felt she didn't get quite enough feedback when she had a question wrong.

Comments dealing with hypotheses regarding the engagement variables of attitude towards accounting and toward computing

Student one had no prior accounting experience, but enjoyed the computer learning environment and was interested in accounting. Student six found lectures boring and this to be a negative factor in his learning.

Formative information for future development

A range of formative issues were raised in the students' comments during the interviews. These formative issues as noted in Figure 6-7 include:

- Student one really liked taking the pre-test and post-test, as she could clearly see her improvement and what she still needed help on.

- A number of students commented on the need for greater interaction with other students and tutors, finding working on their own or waiting for a tutor frustrating. A number of students commented on liking the small group work that took place in some control group tutorials.

- There were a number of student comments regarding their learning style (visual, auditory, kinesthetic). The issue of learning style could be better incorporated into future course work.

- There were a number of negative comments made regarding the quality of the tutors in the control group, pointing to the general need to effectively select tutors and provide them with sufficient training regardless of the learning environment.

In column 2: C=Control group, T=Treatment group; column 3: B=Best, W=Worst

Inter-viewee	**C T**	**B W**	**General comments**	**Comments on control and feedback**
Student one	T	B	Had never done accounting before, enjoyed computer labs and found quite helpful. Found lectures and workshops helpful. Had study partner who also did not know accounting but was interested in accounting Found theory later in course not as practical, felt she was a more visual and kinaesthetic learner	Liked ability to control pace and timing, ability to access anytime, even if she missed a tutorial Liked on-line test feedback, but it was not always clear why she was wrong. Found having to wait for tutor's help frustrating. Liked pre-test and post-test to see how much improved.
Student two	C	W	Did poorly because wife had a baby and then baby was ill. Attended most lectures and tutorials found tutor good.	Enjoyed interaction with other students in tutorials. Found tutorial answer sheets helpful.
Student three	C	W	Re-taking the course in 1998, perhaps a bit overconfident as a	Tutorials were useful and well organised, but not enough

			result. Did not do well in course again 1998.	interaction with other students. Textbook hard to understand, 6 hours per chapter. (English as a second language). Found solutions hard to understand.
Student four	C	B	Had never done accounting before. Found early material more practical, more kinesthetic. Studied with boyfriend, which helped a lot. Got too busy later in the year. Took too many courses and partying too much later in the year.	Found tutor a bit confusing at times. Small group work was very useful in tutorials. Liked solution handouts. Lecturers were good, accurately explained material in a variety of ways.
Student five	C	W	Had done accounting at school (explaining small Bloom's low dif). Worked in a study group, very helpful, also examples in tutorials helped with Bloom's high. Didn't adjust well from school, too much freedom at University!	Tutor was not always sure of self, this is hard for auditory learner like him. Found small group work in tuts good, but too many Asians. Appreciated marked exercises, could discuss with tutor, found solutions good.
Student six	T	W	Was science student, did do 7th form accounting. Interest level is important and he found lectures boring and hard to follow. Finds BusAd interesting (in 1999). English not a problem. Usually studies by himself, not sure of learning style	Control was ok, not too sure about this. Prefers face-to-face where he can discuss and ask questions. Really liked feedback from computer system however.

Figure 6-7: Summary of comments from follow up interviews
(CT =Control or Treatment group; BW = Best or Worst performers)

Synthesis of qualitative data

The synthesis of results from the qualitative data analysis is carried out in line with the objectives of this research study and the related objectives of the various qualitative methods discussed and analysed earlier in this chapter. These include:

- The guiding hypotheses of the research, as shown in Figure 6-2.
- Verification that the activities of the research as designed were carried out and discover any unplanned activities that may have been used.

- ➢ Discovery of additional learning factors that were not included in the original research design.

- ➢ Gaining students' opinions on the positives and negatives of the learning experience.

- ➢ Recommendations arising from the above in support of the formative goals of this research.

Figure 6-8 gives an association matrix of the above objectives as they draw from the qualitative methods used. Under the source of evidence columns the following guide is used: + = supported, 0 = mixed support, - = not supported, N/A = not applicable, ✓ = evidence gathered from this method. The final column of Figure 6-8 gives a summary of the outcome, showing that the given hypothesis is supported, not supported or mixed support based on the qualitative data. A synthesis of the information by research objective is then given in Figures 6-9 and 6-10.

Hypothesis or other objective	Source of evidence					Summary of Outcomes
	Observ-ations	Inter-views	Focus groups	Email	Follow up inter-views	
Primary Hypothesis:						
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	+	+	+	+	+	Supported
Impact of web course on process variables						
2a (i). Support for higher student control	0	+	+	+	+	Supported
2a (ii). Support for improved feedback	+	0	+	+	+	Supported
2a (iii). Support for greater in-context learning	+	+	+	+		Supported
Impact of web course on engagement variables						
2b (i). Better attitude towards course content		0		+	+	Supported
2b (ii). Better attitude towards computers		0		+	+	Supported
2b (iii). Higher time-on-task						N/A
Impact of process variables on engagement variables						
3a. Process variables affecting better attitude towards course content						N/A
3b. Process variables affecting better attitude towards computers						N/A
3c. Process variables affecting higher time-on-task						N/A
Regarding effective learning						
4a. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning					0	Mixed Support
4b. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning					0	Mixed Support
Other objectives						
Verify activities carried out as designed	✓					
Discover additional learning factors	✓					
Positives and negatives of learning experience	✓	✓	✓	✓	✓	
Formative recommendations	✓	✓	✓	✓	✓	

Figure 6-8: Association of hypotheses and other objectives with research methods and outcomes

(N/A = not applicable)

Figures 6-9 and 6-10 present a synthesis of the qualitative data gathered in the various methods covered in this chapter. This information is arranged in the same order as Figure 6-8 but only includes the hypotheses or factors for which there was actual evidence gathered. Figure 6-9 covers the research hypotheses and Figure 6-10 covers the other objectives. During the process of synthesis it was found that all of the "positives and negatives of the learning experience" could be categorised under one of the other headings, especially the negatives as formative issues, and so this has been done for the purposes of parsimony. Also there is some overlap in student comments, in these situations the comments have been put in more than one category. The following abbreviations have been used in the Source column: O=Observation, I=Interviews, F=Focus groups, E=Email, FI=Follow-up Interviews. The Summary of Outcomes column indicates whether the evidence supported the hypothesis or not using the following guide: + = supported, 0 = mixed support, - = not supported, N/A = not applicable

Hypotheses	**Source**	**Description of evidence**	**Summary of Outcomes**
1. Primary hypothesis		Evidence presented below from supporting hypotheses	+
Impact of web course on process variables			
2a (i). Control	O	Students worked at own pace with tutor help on request, some difficulties with navigation of web and Excel during first week	0
	I, F, FI	Really liked anytime/anywhere flexibility	+
	I, E	Really liked self paced nature of system	+
	I	Liked having objectives and suggested times specified at beginning of each episode	+
	F	Student categorisation of positive features of the system largely support structure of the learning survey	+
	I	More help needed on Excel navigation	-
2a (ii). Feedback	O	On-line tests used but limited use of email and discussion groups	0
	I, F, E, FI	Really liked on-line tests	+
	I	Some felt hints and help on tests were insufficient at times	-
	I	Really liked the immediate feedback on the spreadsheets, but some improvement in answers needed	+
	F	Student categorisation of positive features of the system largely support structure of the learning survey	+
2a (iii). In-context learning	O	On-line dictionary, hints on tests and Excel were used but little or no use of on-line text book references.	0
	O, I, F	Really liked the integrated spreadsheet exercises	+
	I	Generally felt that the system was well integrated with	+

		scenarios, tests, and exercises providing a coherent learning system.	
	I	Many unaware of on-line text book references	-
	I, F	Really liked on-line dictionary	+
	I, F, E	Found hints and on-line help useful	+
	F	Student categorisation of positive features of the system largely support structure of the learning survey	+
	E	Liked scenarios situations, like real life	+
Impact of web course on engagement variables			
2b (i). Attitude towards course content	I, E	Trying to learn the accounting and the new computing environment was frustrating for the less experienced students, this improved over the three weeks of the tutorials	0
	E, FI	Very interesting way to learn accounting material	+
	FI	Boring material is hard to learn, this is more interesting	+
2b (ii). Attitude towards computers	I	Some with prior accounting really liked the web enabled environment, but others felt insufficient help available	0
	E, FI	Very interesting way to learn accounting material	+
3. Impact of process variables on engagement variables			N/A
Hypothesis regarding effective learning			
4a. Impact of process support on student learning		Qualitative evidence from the follow-up interviews provided mixed support for this hypothesis	0
4b. Impact of engagement support on student learning		Qualitative evidence from the follow-up interviews provided mixed support for this hypothesis	0

Figure 6-9: Synthesis of qualitative information for hypotheses

The evidence presented in Figure 6-9 regarding the hypotheses of this study are summarised below. Quantitative evidence is presented in Chapters 4 and 4, with a synthesis of all evidence provided in Chapter 7. The summary below is presented firstly in regard to the overall hypothesis 1 and then supported by the directly measured hypotheses 2, and 3. There is some overlap in student comments, in these situations the comments have been put in more than one category.

Overall Hypothesis 1

There is significant support for the overall hypothesis that Web technologies do provide a pedagogically sound foundation for more effective educational systems. The majority of comments from students were positive and appreciative of the Web learning environment. There was however a significant minority who preferred more human contact or a face-to-face learning environment. Overall this hypothesis is supported by the qualitative portion of this study. The following sections provide supporting evidence for this.

Hypothesis regarding process variables

There was significant support for the structure of the learning survey from the focus group sessions, indicating that students' view of the primary process variables of control, feedback and in-context was similar to the researcher's view. This provides additional evidence to support future use of this instrument and theoretical construction.

Hypothesis 2a (i). Support for higher student control: Students worked at their own pace and appreciated the opportunity to do so. They also commented very favourably on the flexibility of time and place that the web enabled system provided them with as well as appreciating the clear description of objectives and expected "time to complete" information provided at the beginning of each episode. On the negative side some students had difficulty initially with navigation of the system and the Excel spreadsheets, pointing to the need for better training. Overall this hypothesis is supported by the qualitative portion of this study.

Hypothesis 2a (ii). Support for improved feedback: Students were strongly positive about the on-line tests and immediate feedback they provided, with similar comments on the interactive Excel spreadsheets (although somewhat less positive). Some felt that the hints and help on the tests were insufficient at times, depending on the background of the student. There was little use of the email and discussion groups due to the lab based setting and presence of a tutor, so there were no strong opinions on the benefits of this feedback mechanism. Overall this hypothesis is supported by the qualitative portion of this study.

Hypothesis 2a (iii). Support for greater in-context learning: Students really liked many of the in-context features including the integrated scenarios and Excel spreadsheet exercises, the on-line dictionary, the on-line tests and related hints and help. There was limited use of the on-line text book references with many students being unaware of them, pointing to the need for making this material more accessible and providing better training to students. Overall this hypothesis is supported by the qualitative portion of this study.

Hypothesis regarding engagement variables

Hypothesis 2b (i). Better attitude towards course content: Some students felt that this was a very interesting way to learn a subject, and was especially useful if the material was boring. There was frustration for some students in trying to learn accounting and having to learn about the computers at the same time. Overall this hypothesis is supported by the qualitative portion of this study.

Hypothesis 2b (ii). Better attitude towards computers: Some students really liked the web enabled learning environment for learning accounting, this was especially the case with those who had some prior accounting experience and so weren't struggling so much with the content of accounting. In some cases students felt the system needed to provide more help. Overall this hypothesis is supported by the qualitative portion of this study.

Hypothesis 4a and 4b. Better performance on tests, including deeper learning on tests: The qualitative evidence did not differentiate between student engagement and student process support for more effective learning. Evidence from the follow-up interviews (Figures 6-6 and 6-7) did indicate that external factors were significant in the student's performance (positive and negative) including such factors as studying with a partner, wife having a baby and English as a second language. Overall these hypotheses have mixed support from the qualitative portion of this study.

The next section covers the remaining objectives of this portion of the study. Figure 6-10 synthesises the qualitative data gathered in the various methods covered in this chapter. The following abbreviations have been used in the Source column: O=Observation, I=Interviews, F=Focus groups, E=Email, FI=Follow-up Interviews

Other Objectives	Source	Description of evidence
Verify activities carried out as designed	O	Activities as designed were carried out, some initial difficulties with navigation in web and Excel due to insufficient training Satisfactory TopClass system performance
	O	On-line dictionary, hints on tests and Excel were used but little use of on-line text book references
	O	On-line tests used but limited use of email and discussion groups
	O	Students worked at own pace with tutor help on request, some difficulties with navigation of web and Excel during first week
Discover additional learning factors	O, E	Spontaneous student assistance of one another points to need for design of small group learning features in the web enabled environment
	FI	External factors can have major impact: wife having a sick baby, difficulty with English, taking on too much, or too much partying
	FI	If the presentation of material is boring (like in lectures) it makes it hard to learn
	FI	Learning style: visual, auditory or kinesthetic
	FI	Learning preference: technology based versus face-to-face
Formative recommendations	O, I, F, E	Need for better student training with web system and Excel, especially navigation and keeping track of where you have been
	I	Some felt that a combination of the web enabled environment and small group discussion would be best
	E, FI	Need to develop small group work in conjunction with web enabled learning environment
	I, F, E	Consistency of quality sometimes a problem, requires more resource during development to assure quality
	I	The anywhere/anytime and self paced nature of the system was considered to be beneficial to students with English as a second language
	I	Some liked having tutor available in room, although frustrating

		having to wait for tutor when busy
	I	Liked having objectives and suggested times specified at beginning of each episode
	I	One international student felt the on-line dictionary was pitched too high for second language students
	I, F, E, FI	Need for a right balance of information when you give a wrong answer, targeted at the student's level of understanding
	F, E	Need to have all learning resources (dictionary, help, hints, examples, textbook references etc.) available at all times
	FI	Pre-test and post-test a valuable way to see improvement and shortcomings

Figure 6-10: Synthesis of qualitative information for other objectives

The evidence presented in Figure 6-10 regarding the hypotheses of this study are summarised below.

Verify activities carried out as designed: The learning activities were largely carried out as designed but there was limited use of some of the features of the learning system including: email, discussion groups and on-line text references. There were also initial difficulties for some students with navigation of the system due to insufficient initial training of students. These difficulties appeared to wane as the tutorials proceeded and students learned the system, receiving help from the tutor or other students as needed. The only extraneous activity noted was some spontaneous assistance of one student to another.

Discover additional learning factors: Spontaneous assistance of one student to another. More is said about this in the formative recommendations below. Student learning preferences and learning styles also became evident as a result of this qualitative investigation. Boredom can be a significant factor and the Web enabled learning environment can contribute to overcoming this problem. A range of external factors can be crucial to student learning including family issues, language problems and poor self management. The web enabled environment can address some of these factors in providing flexibility and additional resources.

Formative recommendations:

- There is a need to provide sufficient training for students using the system for the first time, tailored to their background in computers and the content area being studied.

- A significant opportunity exists to incorporate small group collaborative work with the web enabled learning environment to create the "best of both worlds". This would address the significant minority of students who commented on the need for more of the "human touch", while still providing flexibility, rapid feedback and other benefits of the web enabled environment.

- Developers must be sure sufficient resources are put into producing a consistently high quality of material for the web enabled learning system.

- Linking of the web enabled environment to English language assistance (also available on the web) could provide a considerable enhancement to the system for students where English is their second language, thus enabling them to learn content better while improving their English at the same time. The flexible nature of the system provides further support for these students.

- There is an ongoing need for knowledgeable tutors to support the learning process.

- Clear description of the objectives and expected time to complete should be retained as students found this feature helpful.

- Because students' understanding varies, there is a need to provide tailored feedback and help systems that will maximise student learning in the minimum time. This could be accomplished in part by the use of a diagnostic pre-test, together with ongoing assessment of the student's progress through the material.

- There is a need to make all the learning resources available at all times. This accessibility issue can easily be addressed through a resource bar that is always available from any point in the system.

- Incorporation of a comprehensive pre-test and post-test into the formal web learning environment should be considered as a way of providing benchmarks for students on their entry and exit points from the learning system.

Summary

This chapter has presented the qualitative portion of this study including the design, implementation and results. The design section included the objectives of this portion of the study together with the procedures carried out and the outcomes from each of the qualitative processes followed. These processes included observations, interviews, focus group meetings, a summary of email correspondence and follow-up interviews with the best and worst performers.

The outcome of this work is that there appears to be significant support for the overall hypothesis that Web technologies do provide a pedagogically sound foundation for more effective educational systems. The majority of comments from students were positive and appreciative of the Web learning environment. There was however a significant minority who preferred more human contact or a face-to-face learning environment.

The major formative recommendations from this portion of the study include are supported by the qualitative results from Chapter 5 and include: (1) the need to design collaborative study methods into the web enabled learning system to support more of the "human touch", (2) the need for sufficient resources to be invested to assure quality of the learning environment including appropriate training for students and tutors, (3) a series of more detailed recommendations dealing with the web implementation.

Chapter 7 provides a synthesis of the material from this chapter and the two previous chapters in order to draw together the total results of this study.

Chapter 7: Synthesis of Findings

Introduction

This study has dealt with the fundamental issue of the efficacy of a web enabled learning environment. Three data gathering and analysis methods were used to gain an in-depth view of the learning process, testing a series of hypotheses to establish a supporting chain of evidence and to provide formative insights for future development. This chapter will synthesise the findings of the previous three chapters, showing the interaction of the three primary sources of evidence gathered in this study: experimental results, survey results and qualitative results, as seen in Figure 7-1.

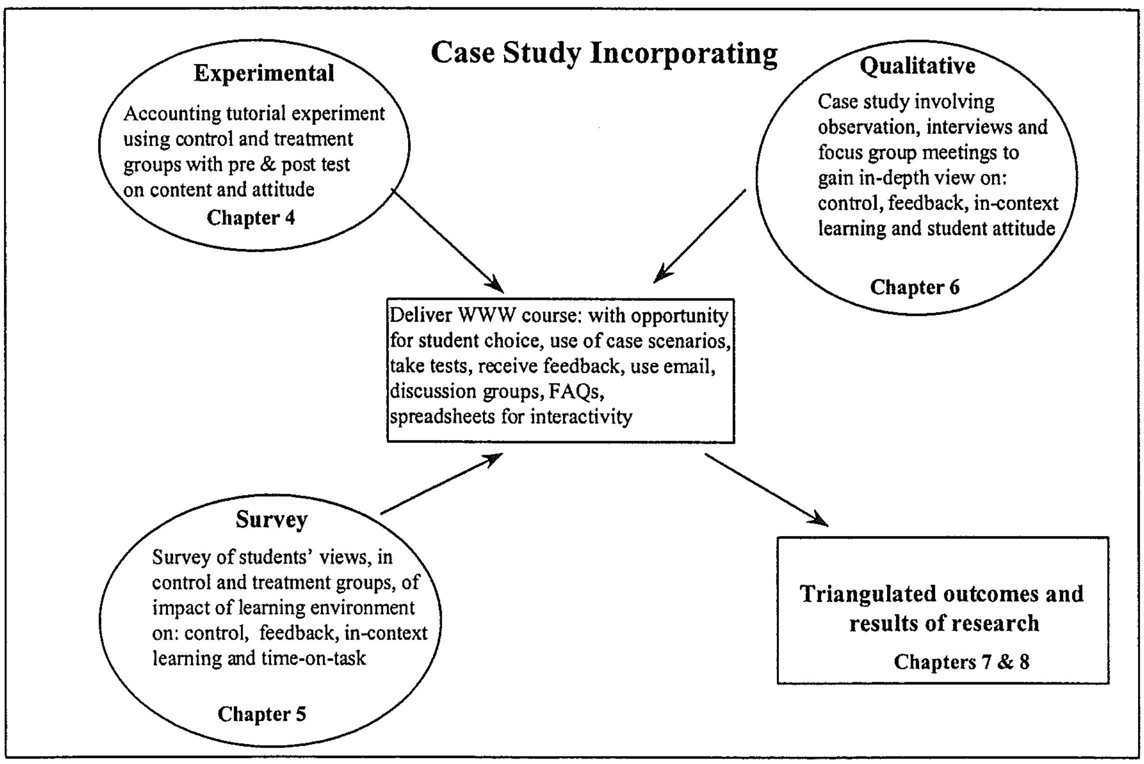

Figure 7-1: Overall research method (from Figure 3-3)

This chapter will elucidate on Figure 7-1, using the following structure:

- Review of research purpose
- Synthesis of evidence to support outcomes and provide a cohesive picture of the research results

➢ Formative recommendations

➢ Summary

Review of research purpose

Figure 7-2 shows the research model that has been followed in this study and has been used in each chapter (Chapters 3 to 6) to provide a map of the research process.

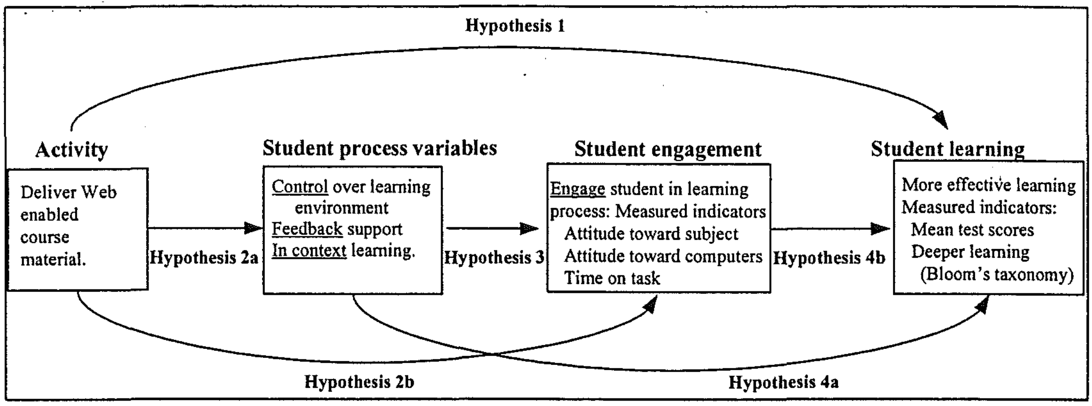

Figure 7-2: Research model (from Figure 3-1)

The research model and related research methods have been used to test a series of hypotheses, as well as providing the basis for capturing formative information to improve future web enabled course designs and related research. The hypotheses tested can be seen in Figure 7-3, which shows the research methods used in gathering data and testing the hypotheses. Under the source of evidence columns the following guide is used: + = supported, 0 = mixed support, - = not supported. The final column of Figure 7-3 provides a summary of the outcome, showing that the given hypothesis is supported, not supported or has mixed support. The following section of this chapter then reviews the evidence that led to this summary of outcomes in a synthesis from the various sources in Chapters 4, 5 and 6.

Hypothesis	Source of evidence			Summary Of Outcomes
	Exer. Ch. 4	**Survey** Ch. 5	**Qualit.** Ch. 6	
Primary Hypothesis:				
1. Web technologies do provide a pedagogically sound foundation for more effective educational systems	+	0	+	Supported
Impact of web course on process variables				
2a (i). Support for higher student control		+	+	Supported
2a (ii). Support for improved feedback		+	+	Supported
2a (iii). Support for greater in-context learning		0	+	Mixed Support
Impact of web course on engagement variables				
2b (i). Better attitude towards course content	+	+	+	Supported
2b (ii). Better attitude towards computers	-	+	+	Mixed Support
2b (iii). Higher time-on-task		-		Not Supported
Impact of process variables on engagement variables				
3a. Process variables affecting better attitude towards course content		-		Not Supported
3b. Process variables affecting better attitude towards computers		-		Not Supported
3c. Process variables affecting higher time-on-task		0		Mixed Support
Hypothesis regarding effective learning				
4a. Higher levels of student process support will yield more effective learning involving better performance on tests, including deeper learning		-	0	Mixed Support
4b. Higher levels of student engagement will yield more effective learning involving better performance on tests, including deeper learning	0	-	0	Mixed Support

Figure 7-3: Association of hypotheses with research methods and outcomes

(from Figure 3-10)

Synthesis of evidence to support outcomes

This section brings together the results of this study, including the quantitative results from Chapter 4 and Chapter 5 and the qualitative results from Chapter5 and Chapter 6. This section is presented in the context of the hypotheses of this study, which are summarised in Figure 7-3.

Each hypothesis is covered below with a summary of the evidence regarding the hypothesis and the overall outcome in terms of whether the hypothesis is supported, there is mixed support for it, or it is not supported. Hypothesis one, the primary hypothesis, is covered first, followed by the underlying hypotheses. This section is then followed by the formative recommendations of the study.

The hypotheses comments that follow will often draw comparisons between the treatment and control groups, focusing on the comparative results of the treatment group as better or worse. As noted in previous chapters, although it is most common to use a significance level of 0.05 (5%) as the cutoff for a significant result, a number of results at the 0.10 (10%) level have been commented on in the study. This is due to the exploratory and formative nature of this study and the importance of avoiding Type 2 errors, that of accepting the null hypothesis, when attempting to discover important influencing factors in an exploratory study. While this has caused results of the study to be a bit more tentative, it also means that emerging learning factors have not been overlooked.

Overall Hypothesis 1: Web technologies do provide a pedagogically sound foundation for more effective educational systems:

The overall hypothesis brings together the individual hypotheses and is tested by the impact analysis used in assessing the experimental results in Chapter 4. This evidence is then supplemented by the survey results of Chapter 5 and the supporting qualitative evidence from Chapter 6.

The impact analysis from Chapter 4 showed that students performed better on tests if they were in the treatment group (the web enabled learning environment) with a significance level of 5% on the overall test scores, 10% on Blooms Low results but a non-significant positive result on the Blooms High results (Figure 4-11a). This result is further supported by comparison to prior studies using effect size as a measure (see Figure 4-15) demonstrating a good level of efficacy in this learning system. This result on the experimental work is linked to Hypothesis 2b (i), attitude towards course content through Hypothesis 4b (Figure 4-11c).

The supporting chain of evidence produced indicates that the improvement in student attitude towards the subject content (accounting) as a result of being in the treatment group (web enabled learning environment) was linked to better learning on tests overall (significant at the 1% level, see Figure 4-11c). This included better results on Bloom's Low scores (significant at the 1% level) and on Bloom's High scores (significant at the 1% level).

However this efficacious result is not linked to Hypotheses 2a (i), 2a (ii) nor 2a (iii) through Hypothesis 4a nor linked to 2b (ii) nor 2b (iii) through Hypothesis 4b based on evidence from Ch. 5 (Figures 5-10d and 5-10e). See the following sections on the individual hypothesis together with the summary of outcomes following Figure 7-4 for further discussion.

An additional factor in the measure of effective learning is attitude towards the content area (accounting) and students in the treatment group showed a better result in this area also (as noted under Hypothesis 2b (i) below).

This result is supported by the descriptive statistics from Chapter 5 and the qualitative evidence from Chapters 5 and 6. This evidence showed that in the view of the students, those in the treatment group had a higher sense of control and better feedback (Figures 5-4 and 5-5) and thought this was a more interesting way to learn accounting (Figures 6-9 and 5-13). They also found the web enabled learning environment a better way to learn and spent significantly less time-on-task, yet learned at least as much (Figures 5-10b and 5-10e).

Thus this hypothesis is supported by the evidence from Chapter 4, has mixed support from Chapter 6 and is not supported by the Chapter 5 impact analysis evidence, but does have some support from the qualitative evidence. So overall the hypothesis that a web enabled learning environment will produce better performance on tests including deeper learning is supported in a link through Hypothesis 2b (i) and Hypothesis 4b but not for the other hypotheses.

However it should be noted that there was a significant minority of students who did not like the web based environment preferring more of the "human touch", demonstrating the variability of student learning styles and learning preferences (Figures 5-10 and 4-13).

It was also noted that those students who had done prior accounting performed better on the Bloom's High results, and that minorities and older students were less likely to have done this prior accounting and thus they tended to perform more poorly on the Bloom's High results (see Figures 4-9a and 4-9b).

In addition evidence from Chapter 6 in the follow-up interviews (Figures 6-6 and 6-7) indicated that external factors were significant in the student's performance (positive and negative) including such factors as studying with a partner, wife having a baby and English as a second language.

Impact of web course on process variables

<u>Hypothesis 2a (i): Support for higher student control:</u>

The descriptive statistics from Chapter 5 (Figure 5-4) indicated that students in the treatment group had a greater sense of control over their learning, with especially strong responses on flexibility of timing and control over pace of learning. This result was strongly supported by the impact analysis (Figure 5-10a) which showed that the treatment had an impact on student sense of control, significant at the 1% level. This was further supported by the qualitative material from Chapter 6 (Figure 6-9) and Chapter 5 (Figure 5-13) with many favourable comments on the flexibility of time and place and control over pace.

On the negative side some students had difficulty initially with navigation of the system and the Excel spreadsheets (Figure 6-9), pointing to the need for better training.

Overall the hypothesis, that a web enabled environment could support higher student control than a traditional learning environment, was supported by the evidence in Chapters 5 and 6.

Hypothesis 2a (ii): Support for improved feedback:

The descriptive statistics from Chapter 5 (Figure 5-5) indicated that students in the treatment group believed they enjoyed greater feedback, with especially strong responses regarding rapid feedback from the on-line tests. This result is supported by the impact analysis, which showed that the treatment had an impact on student sense of feedback, significant at the 1% level (Figure 5-10a). This result was further supported by the qualitative material from Chapter 6 (Figure 6-9) and Chapter 5 (Figure 5-13) with strongly positive comments about the on-line tests and immediate feedback they provided, with similar comments on the interactive Excel spreadsheets.

On the negative side, some students felt that the hints and help on the tests were insufficient at times (Figure 6-9), depending on the background of the student. There was little use of the email and discussion groups (Figure 6-9) due to the lab based setting and presence of a tutor, so there were no strong opinions on the benefits of this feedback mechanism. This result was disappointing given the widely touted benefits of asynchronous communication for drawing students into reflective discussion on course subject matter.

Overall the hypothesis that a web enabled environment could support improved feedback over a traditional learning environment was supported by the evidence in Chapters 5 and 6.

Hypothesis 2a (iii): Support for greater in-context learning:

The descriptive statistics from Chapter 5 (Figure 5-6) indicate that students in the treatment group believed they enjoyed a more cohesive, in-context learning environment, with strong responses regarding the excel spreadsheet exercises, the on-line dictionary and hints provided for the on-line tests. The qualitative material from Chapter 6 (Figure 6-9) supported this view with students indicating they really liked many of the in-context features including the integrated scenarios and Excel spreadsheet exercises, the on-line dictionary, the on-line tests and related hints and help. This result was however not supported by the impact analysis, which demonstrated that the treatment had a non-significant impact on students' sense of the in-context learning environment (Figure 5-10a). The open question evidence from Chapter 5 (Figure 5-13) supports the weak nature of this student process variable, with only one student making any direct positive comment about the in-context issues (one comment about the on-line dictionary).

On the negative side there was limited use of the on-line text book references (Figure 6-9) with many students being unaware of them, pointing to the need for making this material more accessible and providing better training to students.

Overall the hypothesis that a web enabled environment provides greater support for in-context learning over a traditional learning environment had mixed support from the evidence in Chapters 5 and 6.

Impact of web course on engagement variables

Hypothesis 2b (i): Better attitude towards course content:

Students in the web enabled learning environment had a greater improvement in their attitude towards accounting with results significant at the 10% level (Figure 4-11b). This result is supported by the qualitative material from Chapter 6 (Figure 6-9) and Chapter 5 (Figure 5-13) with some students indicating that this was a very interesting way to learn the subject, and was especially useful if the material was boring.

Overall the hypothesis that a web enabled environment could stimulate a better attitude towards the course content of accounting over a traditional learning environment was tentatively supported by the evidence in Chapters 4, 5 and 6.

However on the negative side there was some frustration for some students in trying to learn accounting and having to learn about the computers at the same time (Figure 6-9).

Hypothesis 2b (ii): Better attitude towards computers:

Students in the web enabled learning environment had no significant improvement in their attitude towards computers (Figure 4-11b), the learning environment for the web enabled tutorials. However the qualitative evidence from Chapter 6 (Figure 6-9) and Chapter 5 (Figure 5-13) showed substantial evidence that the majority of students saw the web enabled learning environment as a better way to learn. Students found it interesting and fun, this was especially the case with those who had some prior accounting experience and so were not struggling so much with the content of accounting. On the negative side there was a significant minority who did not share this view and preferred the human touch (Figure 5-13).

The hypothesis that a web enabled environment could stimulate a better attitude towards computers over a traditional learning environment was not supported by the evidence of Chapter 4 but was supported by the evidence in Chapters 5 and 6, thus producing a mixed support overall.

Hypothesis 2b (iii): Higher time-on-task:

The descriptive statistics from Chapter 5 (Figure 5-7) indicated that students in the control group spent an average of 6.27 hours in preparing for and attending the three tutorials while the treatment group spent an average of 4.01. This appears to be a significant difference and is supported by the impact analysis from Chapter 5 (Figure 5-10b) which shows that the impact of being in the treatment group on time-on-task was significant at the 1% level.

Thus the hypothesis that the web enabled learning environment would stimulate a higher time-on-task is not supported, but rather the opposite appears to be the case.

Hypothesis 3: Impact of process variables on engagement variables

The impact analysis from Chapter 5, summarised in Figure 5-10c, shows the effect of the process variables on the engagement variables. This analysis demonstrated that the process variable of control over the learning environment had a significant impact (at the 10% level) on the engagement variable of time-on-task, when using the multiple regression results. The remainder of the process variables appear to have no significant effect upon any of the engagement variables. This demonstrates that the process variables have little indirect impact on student learning further supporting the findings from hypothesis 2a (i), 2a (ii) and 2a (iii) that the process variables have no significant direct impact on student learning.

Hypotheses regarding effective learning

Hypothesis 4a: Student process variables' impact on student learning:

In conjunction with the impact analysis from Chapter 5 (see Figures 5-10d and 5-11), the three process variables of control, feedback and time-on-task were tested for impact on student learning.

Although Hypothesis 2a (i) showed a significant impact of the treatment on the control variable, the higher student control did not translate into better performance on the post-test for Hypothesis 4a (see Figure 5-10d). Thus this hypothesis was not supported for the control variable by the survey portion of this study.

Although Hypothesis 2a (ii) showed a significant impact of the treatment on the feedback variable, the higher student sense of feedback did not translate into better performance on the post-test for Hypothesis 4a (see Figure 5-10d). Thus this hypothesis was not supported for the feedback variable by the survey portion of this study.

Hypothesis 2a (iii) did not show a significant impact of the treatment on the in-context variable, nor did the in-context variable have any significant impact on student performance on the post-test for Hypothesis 4a (see Figure 5-10d). Thus this hypothesis was not supported for the in-context variable by the survey portion of this study.

The qualitative evidence did not differentiate between student engagement and student process support for more effective learning. Evidence from the follow-up interviews (Figures 6-6 and 6-7) did indicate that external factors were significant in the student's performance (positive and negative) including such factors as studying with a partner, wife having a baby and English as a second language. Overall this hypothesis has mixed support from the qualitative portion of this study.

Hypothesis 4b: Student engagement impact on student learning:

In conjunction with the experimental impact analysis from Chapter 4 (see Figures 4-11c and 4-12) the two engagement variables of attitude towards subject content and attitude towards computers were tested for impact on student learning. The third engagement variable of time-on-task was tested in Chapter 5 for impact on student learning (Figure 5-10e).

In Chapter 4 the experimental impact analysis found that students in the treatment group had a more positive attitude towards the subject content, from Hypothesis 2b (i). Testing Hypothesis 4b then demonstrated that a more positive attitude had a very strong positive impact on student learning, significant at the 1% level on the overall test results (Figure 4-11c). The Bloom's Low and Bloom's High results were also significant at the 1% level. Thus this hypothesis was supported for the subject content variable.

However Equation 4b for the computing attitude variable produced a non-significant result (Figure 4-11c). Thus this hypothesis is not supported for the computing attitude variable.

The time-on-task engagement variable was measured in the learning survey from Chapter 5. In conjunction with the impact analysis it was found that time spent in study had a weak positive impact on learning (see Figure 5-10e) when controlling for treatment. Overall, students learn somewhat better in the treatment group, having spent significantly less time (see Figure 5-10b and 6-10e), thus appearing to have an efficiency impact, with less time-on-task. This outcome is contrary to the posited theory, is discussed further in Chapter 8, and should be examined more closely in future research.

The qualitative evidence from Chapter 6 did not differentiate between student engagement and student process support for more effective learning. Evidence from the follow-up interviews (Figures 6-6 and 6-7) did indicate that external factors were significant in the student's performance (positive and negative) including such factors as studying with a partner, wife having a baby and English as a second language. Overall this hypothesis has mixed support from the qualitative portion of this study.

The synthesis of the above results are seen quantitatively in Figure 7-4, which shows the research model with the results from the impact analysis carried out in Chapters 4 and 5 (see Figures 4-12 and 5-11) imposed on the model.

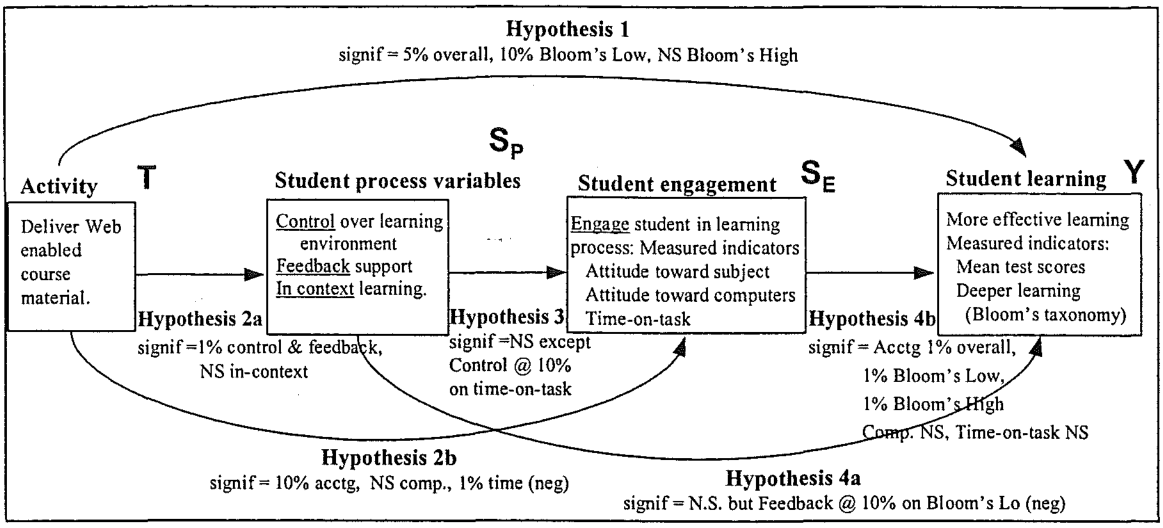

Figure 7-4: Research model with impact analysis results
(from Figures 4-12, 5-11)

The supporting chain of evidence shown in Figure 7-4 is:

- Hypothesis 1: The treatment (T, the web enabled learning system) had a significant positive impact on student learning (Y, significant at 5% overall, 10% on Bloom's Low, NS on Bloom's High)

- Hypothesis 2b: The treatment (T, the web enabled learning system) had a significant positive impact on student attitude towards the subject content area (S_E accounting, significant at the 10% level) and

- Hypothesis 4b: A positive attitude towards the subject content area (S_E accounting) had a strong impact on student learning (Y, significant at the 1% level overall and on Bloom's High and on Bloom's Low).

Additional positive outcomes included:

- Hypothesis 2a: There was a strong positive impact of the treatment (T, the web enabled learning system) on the students' sense of control and feedback (S_P, significant at the 1% level).

- Hypothesis 2b: The treatment had a strong negative impact on time-on-task (significant at the 1% level), but student in the treatment group still outperformed the control group, indicating a strong efficiency gain.

- Hypothesis 3: Students with a higher sense of control spent more time-on-task.

Negative outcomes included:

- Hypothesis 4a: There was a negative impact of feedback on Bloom's Low (significant at 10% level) This may be seen in Figures 5-10c and 5-11 which show a significant negative impact of Feedback on Bloom's Low (10% significance level).

- Hypothesis 1: Not all students enjoyed the web enabled learning environment, with a significant minority preferring more human contact in the learning process. Some students also found it frustrating trying to learn the computer environment while struggling with the course content also.

- Formative: There was a range of negative comments from students, pointing to formative recommendations that are covered in the next section of this chapter.

Although there is support for most of the hypotheses, the mixed nature of that support requires further discussion and investigation. In addition the interactions between the hypotheses as shown in the research model do not appear to be an accurate reflection as seen in this study. Discussion of these issues and a closer look at the implications for the theory model will be considered in Chapter 8.

Formative Recommendations

In line with the formative objectives the following is a summary of the formative recommendations, including the additional learning factors discovered, from Chapter 6 and Chapter 5. Figure 7-5 presents these formative recommendations in abbreviated form, categorised into recommendations dealing with student control, feedback, system quality and learning system effectiveness. Figure 7-5 is also sorted into order within the categories, by level of importance of the recommendation. This ordering is based on the strength of the evidence arising from this study and the potential for impact on achieving Bloom's 2-sigma effect (see Chapter 2, at end of Effective

Learning section). This is then followed by a fuller description of each recommendation.

Category	Import-ance	Description
Control	1	Sufficient training for students and tutors
	1	Make all learning resources available at all times
Feedback	1	Incorporate small group collaborative work into web design
	2	Need for knowledgeable tutors
	2	Clear description of objectives and time requirements
	2	Feedback systems tailored to student level
	2	Comprehensive pre and post-test to demonstrate progress
Quality	1	Invest sufficient resources to assure quality learning materials
	1	Verify system hardware and software performance
Effective-ness	1	Carry out further research on learning efficiency gains that ran counter to Hypothesis 3c regarding increase for time-on-task
	1	Carry out further research on entire courses (not just tutorials)
	1	Emphasise acquisition of computer skills
	2	Design in additional English language support
	2	Consider student learning styles and learning preferences
	2	Enliven learning material with games and other boredom destroying materials
	2	Address external factors where possible

Figure 7-5: Summary of formative recommendations

The following provides a fuller description of the above recommendations:

Control

- The need to provide sufficient training to both students and tutors at the outset of use of new web enabled learning systems, including appropriate use of self paced techniques. This training should be tailored to the background of tutors and students to bring them up to a satisfactory level of competence in navigation and use of the system prior to engaging in course content learning activities.

- There is a need to make all the learning resources available at all times. This accessibility issue can easily be addressed through a resource bar of hypertext links that is always available from any point in the system.

Feedback

- A significant opportunity exists to incorporate small group collaborative work with the web enabled learning environment to create the "best of both worlds". This would address the significant minority of students who commented on the need for more of the "human touch", retaining the social context of learning, while still providing flexibility, rapid feedback and other benefits of the web enabled environment.

- There is an ongoing need for knowledgeable tutors to support the learning process and provide more of the human contact many students need, retaining the social context of learning.

- Clear description of the objectives and expected time to complete should be retained as students found this feature helpful.

- Because students' understanding varies, there is a need to provide tailored feedback and help systems that will maximise student learning in the minimum time. This could be accomplished in part by the use of a diagnostic pre-test, together with ongoing assessment of the student's progress through the material.

- Incorporation of a comprehensive pre-test and post-test into the formal web learning environment should be considered, as a way of providing benchmarks for students on their entry and exit points from the learning system.

Quality

- Sufficient resources need to be invested in web enabled learning environments to assure the overall quality of the systems.

- Need to verify that server hardware and software are performing satisfactorily.

Effectiveness

- Additional research be carried out on the time-on-task issue to discover more about the efficiency issues highlighted by the evidence not supporting Hypothesis 3c: Higher time-on-task.

- Further research be carried out on flexible learning application of web enabled learning environments where the entire course (not just a portion of tutorials as the case in this study) is undertaken in this environment.

- The need to emphasise the acquisition of computer skills within the context of life long learning skills and learning other disciplines. Given the demands of the work environment this would be a strong effectiveness benefit of the web enabled learning environment.

- Linking of the web enabled environment to English language assistance (also available on the web) could provide a considerable enhancement to the system for students where English is their second language. This would enable them to learn content better while improving their English at the same time. The flexible nature of the system provides further support for these students.

- Need to consider different student learning styles and learning preferences when designing the web enabled learning environment.

- Boredom can be a significant factor in many disciplines and the Web enabled learning environment can contribute to overcoming this problem through interaction and features that address the learning style of the student.

- A range of external factors can be crucial to student learning including family issues, language problems and poor self management. The web enabled environment can address some of these factors in providing flexibility and additional support resources.

Summary

This chapter has synthesised the qualitative and quantitative evidence from this study.

A supporting chain of evidence demonstrated that the web enabled learning system appears to have had a significant impact on student attitude towards the content area (accounting) and a more positive attitude towards the content area had a strong impact on student learning. In addition there appeared to be a strong positive impact of the web enabled learning environment on the students' sense of control and feedback.

A range of formative recommendations was also made related to student control, support for feedback, system quality and effectiveness of the learning system.

Although there is support for most of the hypotheses, the interactions between the hypotheses as shown in the research model do not appear to be an accurate reflection as seen in this study. Discussion of these issues and a closer look at the implications for the model will be considered in Chapter 8. Chapter 8 will also consider the significance of the findings, implications for practice and rival interpretations of the results.

Chapter 8: Discussion and implications of findings

Introduction

This chapter will discuss the findings from the previous chapters considering the significance of those findings and the implications of the research outcomes. Thus this chapter will address the question "Does the Internet provide a pedagogically sound foundation on which to build more effective higher education systems"? The discussion will also consider what has been discovered about the learning process in this environment and what progress has been made toward Bloom's 2-sigma effect. This is the impact that one-on-one tutoring has on student performance (Bloom, 1984; Woolf, 1992) producing performance that is two standard deviations (sigma) better than students in classroom settings (30 students with one teacher). The challenge is to find cost effective ways of achieving the 2-sigma effect.

This chapter is organised as follows:

- Discussion of findings in light of the literature
- Significance of the findings
- Implications of results for theory
- Implications of results for practice
- Rival interpretations of the findings
- Limitations of study
- Implications for future research
- Summary

Discussion of findings in light of the literature

This section will consider the findings of this study in the light of the literature covered in Chapter 2. This analysis will then lead on to the implications of the study outcomes for theory and for practice. This section will look first at the overall purpose of the study and the extent to which the study outcomes supported or did not support this purpose. There will also be a discussion of how these results relate to the literature and consideration of the meaning of these outcomes in relation to effective learning.

As noted in previous chapters, although it is most common to use a significance level of 0.05 (5%) as the cutoff for a significant result, a number of results at the 0.10 (10%) level have been commented on in the study. This is due to the exploratory and formative nature of this study and the importance of avoiding Type 2 errors, that of accepting the null hypothesis, when attempting to discover important influencing factors in an exploratory study. While this has caused results of the study to be a bit more tentative, it also means that emerging learning factors have not been overlooked.

Discussion of supporting results from the study

Some of the results from this research provided substantial support for the hypotheses under study, while other results do not. This section will discuss the supportive findings.

Overall purpose of this study

The primary hypothesis for this study was developed from a number of sources. Leidner and Jarvenpaa's (1995) recommended that:

- "Early research in the area of learning improvements that may be facilitated with information technology is thus needed..." and
- "Although we are unaware of research that examines the potential of the World Wide Web in the context of classroom analyses… research examining uses of the Internet and the WWW is much needed."

Juxtaposed to this need for research is Clark's assertion that the learning environment can not affect the learning outcome (Clark, 1983; Clark, 1994). The primary hypothesis of this study, that Web technologies do provide a pedagogically sound foundation for more effective educational systems, was designed to test Clark's assertion in a systemic way while supporting Leidner and Jarvenpaa's recommendations.

Why is this issue important? The adoption of technology to support learning in higher education is a hot topic because, as Jones and Paolucci (1999) put it:

> "Given that educational technologies are currently receiving significant attention, questions are now being raised regarding the research and assessment results that support the adoption and inclusion of technology in all levels of the educational system, particularly because the investments have been and remain so high."

So the issue of whether technology is a worthwhile educational investment is part of the equation, and the key point seems to be, do technology supported learning systems provide for improved learning or other direct and measurable benefits? Charp (1998) illuminates this by saying:

> "With all the studies and documentation available, research on why and how the use of technology is effective in education remains minimal...challenges remain for accurate and meaningful research to ensure the proper use of technology in education"

So the problem highlighted in the literature is that large investments are being made in technology mediated learning systems with insufficient evidence that these systems are educationally effective. If they are effective, "how and why" do they work? The outcomes of this study help to shed some light on these questions.

Evidence in support of primary hypothesis

The strongest evidence from this study supporting the primary hypothesis is from the experimental portion of the study from Chapter 4 with supporting evidence from the Survey (Chapter 5) and Qualitative (Chapter 6) portions of the study and includes:

- Students in the treatment group performed better (significant at the 0.05 level) than those in the control group on the pre-test/post-test learning measurement of course content on Hypothesis 1.

- Students in the treatment group experienced an improvement in their attitude toward the course content when compared to the control group (significant at the 0.10 level) on Hypothesis 2b (i)

- The interaction between an improved attitude and student test performance was the strongest outcome showing that those in the treatment group had an improved attitude toward the course content and that this improvement in attitude was associated with better test performance (significant at the 0.01 level) for both deep and surface learning using Bloom's High test items and Bloom's Low test items on Hypothesis 4b.

- Students in the treatment group spent less time-on-task (significant at the 0.01 level), and yet as noted above, performed better on tests for both surface and deep learning questions (using Bloom's taxonomy) on Hypotheses 2b and 4b. Also student's sense of control over their learning environment had an impact on time-on-task (significant at the 0.10 level) for Hypothesis 3c.

How do these outcomes relate to the literature, do they indicate that more effective learning is taking place in the web mediated environment and what are some of the possible reasons for the outcomes?

Discussion of supporting evidence

Borthick and Clark (1987) identify five key attributes for measurement of learning outcomes where technology is used in accounting education. These five include:

1. Performance on tests

2. Student attitude

3. Relevance to accounting practice

4. Resources used

5. Time required for completion

It is interesting to note that the positive outcomes from this study directly address three of these five learning outcomes: student performance, attitude and time issues.

These substantive features from the positive outcomes of this study are interlinked considering the impact of attitude on student performance in a web enabled environment and the impact of time-on-task on student performance.

Student attitude toward subject content

Bloom and others considered learning effectiveness to include both content learning and attitude change (Bloom, 1956; Bowden & Marton, 1998). Leidner and Jarvenpaa (1995) consider attitude in the outcome dimension of their theoretical model under the headings of affective, motivation and attention. Both of these components of effective learning appear to be supported in this study with students in the treatment group experiencing improved attitudes towards the content area and improved learning of the content as measured by the pre/post-tests administered. This improved performance included both deep and surface learning.

Why is attitude an important variable? How is it that a web mediated learning environment seems to improve attitude? Ross and Moeller (1996) indicate that attitude seems to be a learning variable that incorporates motivation to learn as well as anxiety about learning. Motivation can provide the "liking" to draw a student to the point of wanting to learn while anxiety can produce the opposite result. A learning environment that increases a student's liking for the subject while reducing the anxiety appears to draw students into the learning experience with positive results. Naturally to accomplish this with an Internet enabled course requires a good design that will increase liking and reduce anxiety.

Zhang & Espinoza (1998) found that students who had less anxiety (a subscale of attitude) toward computers had higher computer self efficacy and saw learning computer skills as more desirable. They used the Attitudes Toward Computer Technologies (ACT) survey by Delcourt & Kinzie (1993) in carrying out their research. The statistically significant outcome found by Zhang & Espinoza is supported by the findings of Delcourt & Kinzie (1993) that self efficacy was essential to the effective learning of computers. Massoud (1991) found that positive attitudes toward computers correlated significantly with computer learning in adult students.

Not all studies have produced affirmative results however. The impact of attitude on time-on-task and student exam performance was studied by Montazemi & Wang (1995). They found that attitude toward computers did not have any significant impact on time-on-task, but that time-on-task was significantly correlated with exam performance. In a study of accounting student attitude change, Abraham et al (1987) found that students using a computerised practice set had a significant improvement in attitude toward accounting when compared to a control group, however there was no significant difference in test performance as reported in this study.

Faux and Black-Hughes (2000) raise the additional issue of attitude and interest in a subject:

> "Teaching students about social work history has been a challenge for educators, who are aware of student comments about the subject being boring or the presentation of the material being less than intellectually stimulating."

If students are bored with a subject they will probably not like it, creating a lack of motivation in their attitude toward the subject matter. Contrary to the outcomes of the current study however, Faux and Black-Hughes found that students in the control group (traditional lectures) of their study performed better than the students who learned in the Internet enabled environment. The reasons for this outcome centred around students not liking the Internet environment due to lack of feedback from the system and anxiety in using the Internet and getting lost in the system. This highlights the attitude issue once again and emphasises the need for Internet based systems to incorporate good instructional design including adequate interactivity and feedback together with sufficient student training in its use to overcome the "lost in cyberspace" problem. The issues of feedback and anxiety about learning with computers are covered later in this section, since they are variables this study addresses.

The studies noted above vary in their outcomes. Some support the concept that a more positive attitude may be engendered by using well designed computer systems and will result in better performance on tests, while other studies produce contrary results. The current study results report that students in the treatment group did show an improved attitude and this improved attitude correlated significantly with improved performance on tests. Why the conflicting results? One of the reasons may be the content area and the level of student interest in the subject matter.

A common thread between the Faux and Black-Hughes study and the current study however is the issue of the subject content being viewed by students as being boring. It may well be that strong positive attitude changes as experienced in this study may be limited to subjects perceived to be boring by students, especially those that are mandatory for degrees such as science, engineering, accounting and other professional degrees. It may be equally true that this key attitude variable may be less efficacious in Internet enabled environments where the students have chosen to study the subject matter out of interest rather than due to the subject being a required part of a technical or professional degree.

What are the system characteristics that cause Internet technologies to be an enabler of a better attitude when compared to the typical University lecture? As Whitehead (1929) put it "Education with inert ideas is not only useless, it is harmful...". Often a lecture to hundreds of students is "education with inert ideas". This is difficult to overcome effectively in such large groups. Technology offers a way to provide interaction with the ideas, individually or in small groups, while providing access to appropriate information and feedback so the student understands how they are progressing. Soloway and Prior (1996) discuss the concept of scaffolding as a way of providing appropriate levels of support for the learner in more "real" situations, in which the student can discover and understand living ideas rather than inert ones. This can lead to what Negroponte (1995) calls the "joy of learning", that point at which the student "gets it". The point at which the inert idea comes to life. This is certainly part of the explanation why attitude is an important variable. Well designed technology learning environments appear capable of enabling this "joy of learning" through such characteristics as interaction and scaffolding. From the experience of Faux and Black-Hughes it is equally clear that the technology based systems can be poorly designed, and produce the opposite result.

Time-on task

Regarding the issue of time-on-task, Kulik and Kulik (1987) suggested that students in computer mediated learning environments would spend less time-on-task.

However Norman and Spohrer (1996) asserted that the opposite would be true, stating that an "...engaged student is a motivated student... which correlates well with time-on-task...". The outcomes of this study seem to support Kulik and Kulik's assertion that time-on-task would be lower. Yet in spite of lower time on task, the treatment group students seemed to learn more and enjoy the experience more.

This would appear to contradict the findings of Montazemi & Wang (1995), who found a significant relationship between time-on-task and performance in a computer supported mastery learning system for an information systems course. They found that student's who spent more time learned more. Cavalier & Klein (1998) found that providing instructional objectives to students in a computer mediated earth science course had a significant positive impact on time-on-task and on student performance in tests. Kashy et al (1998) reports anecdotal evidence that increased time-on-task was a major factor in improved student learning in a new technology mediated physics course. Cookman (1998) also reports anecdotal evidence that considerably higher time-on-task and student engagement occurred as a result of using a computer based learning system in a graphics design course. However, Abraham et al (1987) found no significant difference between the control group (traditional classroom) and the treatment group (computerised accounting) in terms of the amount of time-on-task, nor any difference in student performance on tests.

These conflicting results are in contrast to the outcome of the current study, which found that the treatment group spent less time-on-task than the control group. This may be explained in that the current study compared a control group in a traditional learning environment to a treatment group using a web enabled learning environment. It was under these circumstances that the treatment group learned more in less time than the control group. This study also considered intra-group time-on-task results against student performance and found a positive, but non-significant result.

Why this efficiency gain when using a web mediated learning environment? Part of the answer may be in the attitude issue discussed earlier. A better attitude toward the subject may well translate into more focussed attention and a quicker ability to understand the material. In addition Larsen (1992) suggests that permitting students to spend as much time on a screen as they wish enables the student to use their individual learning strategy and thus to learn more. This interaction between student control over the learning environment and student learning was tested in the current study. Although producing mixed results (see the next section) one interesting outcome was the impact of the control variable on time-on-task (significant at 0.10 level). Students who felt they had more control over the learning environment spent more time-on-task. This result is supported by Ross and Moeller (1996) who suggest that higher levels of student control over the learning experience in a technology mediated learning environment will result in students spending more time on task and the students will learn more as a result.

This efficiency gain as a result of learning in the web enabled environment present an important opportunity for converting such additional available study time into additional learning, which would carry the student closer to the 2-sigma effect. An important future area of research could be how to motivate students to make use of this learning efficiency to generate more effective learning.

The final area to discuss in this section is that of deep learning. Deep learning in this study was measured using multiple-choice test items based on Bloom's taxonomy as the model for differentiating deep versus surface learning. Cox and Clark (1998) suggest that both formative and summative testing can be accomplished using multiple-choice items based on Bloom's taxonomy. Multiple-choice (MC) test items have certain benefits in carrying out such testing. MC tests produce a consistent result with no marker bias, they also permit a wide range of material to be covered in a relatively short period of time and are computer gradable. According to Brightman et al (1984) such formative tests provide timely feedback to the student and teacher, and identify specific student problem areas. Timely feedback is a critical factor in building student confidence and overcoming learner anxiety (Ross & Moeller, 1996). As noted earlier these concepts are characteristics of student attitude. Cassarino (1998) states that MC questions can be used to assess all levels of cognition including higher level thinking such as application, analysis and synthesis.

Mehta & Schlecht (1998) describe their experience in a large engineering class using short quizzes based on Bloom's Taxonomy to determine depth of learning. They found that 90 percent of the students in the class thought that teaching and learning was better when compared to other large classes they had taken. Mehta & Schlecht also report that those students benefiting most from the formative quizzes were those with lower grades (below 2.7 GPA).

Using a form of Bloom's Taxonomy called the RECAP model (Imrie, 1995) formative quizzes were used by Cox & Clark (1998) to assess deeper levels of cognition in a computer programming course. Cox & Clark had the aim of moving students through the lower levels of cognition and building on this understanding until students were able to apply their understanding to new domains and problem solving levels. Anecdotal evidence supported a positive outcome.

Two studies conducted by Buchanan with psychology students (Buchanan, 2000) found that usage of a Web mediated formative assessment, consisting of multiple choice test items, did produce significant results in predicting student performance on the final exam.

Not all results in computer mediated learning environments have been positive however. Gierl (1997) reports the use of a problem solving assessment based on Bloom's Taxonomy in a mathematics course. Results suggest that Bloom's Taxonomy does not provide an accurate model for anticipating the cognitive processes used by students. This experiment only covered the lowest three levels of Bloom's Taxonomy.

A random assignment experiment in a large American Government course used formative Web multiple choice quizzes. The researchers found no significant difference on post-test scores between students who were assigned the Web quizzes and those who were not. (Class & Crothers, 2000)

The results of the current study showed that students from the treatment group, when compared to the control group, experienced a greater improvement in their attitude toward the course content of accounting (significant at 0.10 level) and this was associated with better results on both the Bloom's Low and Bloom's High portions of the post-test. This provides supporting evidence for the hypothesis that a web mediated learning environment can support deeper learning.

Myers (1999) asserts the importance of teaching and learning more than just knowledge (the lowest level of Bloom's taxonomy). He urges the use of sound instructional design including instructional objectives set at the various levels of cognition and linked to the course work. To complete the cycle of learning students and teachers need to know if learning occurred in a robust and verifiable way. This is where both formative and summative testing come in, linked to the instructional objectives to find if students have learned the material to the anticipated level of cognition.

This study provides evidence that deeper learning can be supported by web based learning environments. The evidence from Ramsden (1992) and others indicates that deeper learning is better retained, more useable in practical situations and more transferable to new circumstances. All of these features make deeper learning a desirable outcome, and therefore one worth measuring in this type of research. If web enabled learning systems can effectively support deeper learning, as indicated by this study, then they are systems that should be refined and developed further for the learning benefits they offer.

In summary, improvements in student attitude appear to be linked to improved student learning performance, and an improvement in attitude seems to be linked with a web mediated learning environment, at least in the accounting discipline for this study. It is possible that the learning impact of a positive attitude towards the content area is a feedback loop: when students are more positive they learn more with less effort, and as they learn more they become more positive, which helps them to learn still more, and do so more efficiently.

The evidence from this study appears to contradict Clark's assertion that the learning environment cannot affect the learning outcomes, rather supporting his admission (see Ullmer, 1994) that media can have "attitude and engagement possibilities" and indicating a strong link between the learning environment, attitude, and student test performance.

If this result can be enhanced through better designed systems and collaborative work to produce even more efficacious results, then the goal of achieving the 2-sigma effect may come within the grasp of future educators.

Mixed and negative results from the study

Not all of the results from this study were strongly positive, with some of the experimental results producing negative outcomes, although there may have been some positive results from the survey or qualitative portions of the study, thus producing a mixed result. This section will look at these outcomes and discuss them in the light of the literature.

In addition to the supported hypotheses discussed in the previous section, a range of additional hypotheses were tested in this study, the outcomes of which produced mixed or negative results. These included:

- Students in the treatment group experienced a higher sense of control over their learning environment (significant at the 0.01 level), however this positive result was not linked to better performance on the pre-test/post-test learning measurement of course content (Hypothesis 2a and 4a). The student sense of control also had no significant impact on student attitude toward course content or computers (Hypotheses 3a and 3b). However student sense of control did had an impact (significant at the 0.10 level) on time-on-task, which was discussed earlier (Hypotheses 3c).

- Students in the treatment group experienced a higher sense of feedback (significant at the 0.01 level), however this positive result was not linked to better performance on the pre-test/post-test learning measurement of course content (Hypothesis 2a and 4a). In fact the opposite was the case with a negative result on the Bloom's Low learning level (significant at the 0.10 level) The student sense of feedback also had no significant impact on student attitude toward course content or computers, nor on time-on-task (Hypotheses 3a, 3b and 3c).

- Student's sense of the learning being in-context was found to have no significant difference between the treatment and control groups, and no impact on student performance on the tests. There was however support from the qualitative evidence that the web environment was a more in-context learning environment. Hypothesis 2a and 4a

- Students' attitude toward computers was found to have no significant difference between the treatment and control groups, and no impact on student performance on the tests. There was however support from the qualitative evidence that the web environment engendered a more positive attitude toward computers. Hypothesis 2b and 4b.

How do these outcomes relate to the literature and what are some of the possible reasons for the outcomes? The following discussion will focus on the major issues arising from these results.

Discussion of mixed and negative results

Student control

Leidner and Jarvenpaa (1995) suggest that one of the key process dimensions is the student control dimension and that on the outcome dimensions of Levels of Learning and Cognition, higher-order thinking and more conceptual understanding would be associated with greater student control. They stated that one of the assumptions of CAL (Computer Assisted Learning) was that it provided better student control. Creating a learning environment where students have more control and more interactivity is purported to create more effective learning. (Eaton, 1996; Eklund, 1996; Laurillard, 1993). In addition, concepts of deeper learning are supposed to be associated with more student control (Ramsden, 1992; Entwistle, 1983). The results of this study show through the qualitative and quantitative analysis that higher levels of control can be supported by a Web enabled learning environment. However, higher levels of control were not linked to higher student performance on tests.

Steinberg (1989) indicates that there is a pervasiveness of inconclusive findings in research regarding learner control. The current study confirms this broader finding. Relan (1995) suggests that insufficient training in use of the system, or use of inappropriate learning strategies by students may mean that the best use of learner control systems is not achieved. One of the formative findings from this study, the need for more initial student training on the system, supports this. Perhaps additional training on appropriate learning strategies may also improve student performance with such systems. The issue of user interface ease of use was also raised by Ross and Moeller (1996). This included the need for testing of the interface so that student control is efficiently exercised without frustration. This issue was raised by some students in the qualitative portion of the current study and may be an additional factor preventing improved control from translating into improved and deeper content learning. These issues may also be factors contributing to the lack of support for the hypothesis that improved control of the learning environment would result in a better attitude towards the course content.

Greater student control may well lead to greater student learning independence, and given the increasing demands of life long learning to maintain employability (Eden, 1996), such learning independence may prove to be invaluable in the future knowledge economy.

Feedback

Ramsden (1992) asserts that appropriate assessment and feedback are important features of good teaching and enhanced student learning. Immediate feedback so that students can see and correct their errors in understanding is suggested by Jackson (1996) to be a valuable scaffolding strategy in computer mediated learning environments. In their meta-analytic study of feedback in technology mediated learning environments Azevedo and Bernard (1995) found that immediate feedback was more efficacious than delayed feedback. In addition they found that having access to supplemental materials as part of the feedback process was beneficial to student learning.

Feedback can be formative or summative in nature. Summative assessment and feedback is the type that help teachers assign grades to students; tests, exams and formal assignment are examples. Formative assessment and feedback is the type used to help students see how they are doing during the course of their learning. Angelo and Cross (1993) use the analogy of a sailing ship navigating to various ports of call.

They suggest that a port of call is like summative assessment and feedback, while navigation in route to a destination is like formative assessment. Without good formative assessment and feedback student will find it difficult to get to a successful final exam. This study provided students with a web mediated system of formative feedback with access to supplemental materials, and then measured their performance on a summative post-test. On the learning survey student's in the treatment group said they were getting a better level of formative feedback (significant at the 0.01 level), however this improved feedback did not appear to be linked to better performance on the summative post-test. In fact the opposite appeared to be the case with a negative result for the feedback variable on Bloom's Low student learning. This may indicate that students with the least experience of the subject matter were overly optimistic about the feedback they received, perhaps thinking that they learned more than they really had, and thus performing more poorly than their positive regard for feedback justified.

Why has better formative assessment and feedback not translated into more effective learning? Ross and Moeller (1996) suggest one possible reason, that "independent navigation through hypermedia lessons requires adequate subject matter knowledge." Some student comments on the survey and in interviews suggested that learning the new system while also learning a new subject was very hard. This would seem to indicate that those students with little prior accounting subject matter knowledge, struggled with the necessary "independent navigation through hypermedia lessons". This obstacle is a possible explanation for the lack of linkage between the formative and summative feedback in the web mediated learning environment. Smith (1996) supports this idea by asserting that some students will not do well in a self directed environment. Smith goes on to say that these students prefer face-to-face settings for the social interaction. This study also found in the qualitative evidence that many students preferred more of the human touch, that they found often missing in the web mediated learning environment.

An additional possible explanation for the lack of linkage from higher feedback to better test performance may be related to the finding by Azevedo and Bernard (1995) noted earlier, that access to supplemental materials was an effective part of the feedback process. The current study did include access to supplemental materials, however many students did not make use of the materials, since they were not available on screen at all times. Formative recommendations to deal with each of these issues are described later in this chapter.

Entwistle (1983) suggests that in-context, or situated, learning will be associated with more effective and deeper learning. This is supported by Ramsden (1992) who talks of "real versus imitation" subjects, and uses the analogy of teaching a deaf person to play the piano. Yes we can teach the deaf person to press the right keys at the right time, but they will never really have an appreciation for music, because they have no context, they cannot hear the music. Adding context to a subject as it is taught should produce a deeper and more transferable understanding of the subject matter. The current study attempted to create a more in-context learning environment. It was hypothesised that this would lead to more effective learning, including deeper learning. The experimental results of the study did not support either the hypothesis that the web environment was more in-context, nor that this linked to more effective learning. The qualitative evidence, however, did provide support for a more in-context learning environment.

Why this outcome and what can be done about it? The issues noted earlier of students with little background in the subject matter having difficulties in the independent navigation hypertext environment may mean that the additional context added little value for these students, as they were struggling with both the content and environment. Choi and Hannafin, (1995) state that:

> "Situated cognition emphasizes the importance of context in establishing meaningful linkages with learner experience and in promoting connections among knowledge, skill and experience."

If students have little experience or knowledge of the subject, adding context may not be helpful (Bryant & Hunton, 2000). This study was conducted with first year students in an introductory course on accounting. It is possible that students' lack of experience and knowledge prevented the in-context aspects of the web environment from being beneficial to them. How might this problem be overcome? It is possible that adding more scaffolding for less experienced students or having students learn in small collaborative groups would help. This might help students to gain the experience necessary to make effective use of the context material. Formative recommendations to deal with this issue are described later in this chapter.

Attitude toward computers

Fletcher-Flinn and Gravatt (1995) suggest that students' attitudes toward computers should be an important factor in student learning. Woodrow (1991) supports this stating that:

> "Negative attitudes must not be allowed to limit the knowledge and creativity of potential computer users, nor anxiety to interfere with the learning process."

The fear of computers may afflict up to one third of US students (DeLaughry, 1993). Such a negative attitude, may well have an impact on student learning in a computer mediated environment. Equally, positive attitudes toward computers may enhance student learning, and such was the hypothesis in this study. However the study outcomes did not support this. The treatment was not linked to an improvement in student attitude regarding computers, nor was there any linkage between computer attitude and student performance on the post-test. This outcome may be caused by the fact that many of the students in this accounting course were concurrently taking an introduction to computing course and so there may not have been a high level of computer anxiety in the first place. This is supported by the survey evidence which showed that both the treatment and control groups had fairly positive attitudes toward computers prior to starting the experiment, with mean scores of 4.5 and 4.3 respectively on a 6 point likert scale.

Significance of the findings

The primary question in this study is does "...the Internet provide a pedagogically sound foundation on which to build more effective higher education systems"? One way of reflecting on the significance of the findings is to consider how far towards Bloom's 2 sigma effect technology based learning systems have taken us.

In Chapter two the 2-sigma effect was described as the impact that one-on-one tutoring has on student performance (Bloom, 1984; Woolf, 1992). Chapter two further pointed out that a number of Bloom's graduate students' research demonstrated that students instructed in one-to-one tutoring settings performed two standard deviations (sigma) better than students in classroom settings (30 students with one teacher). In other words the average tutored student performed better than 95% of the classroom students. Unfortunately one-on-one tutoring is a prohibitively expensive way to deliver education. The challenge Bloom posits is finding cost effective ways of achieving the 2-sigma effect, and systems of sound pedagogy and modern technology offer one avenue of research in taking up this challenge.

Figure 8-1 shows a comparison of the effect sizes of: (1) prior work in the area of CAI and CAL (Kulik et al, 1980; Kulik & Kulik, 1987; Krendl & Lieberman, 1988), (2) the results of this study using Web enabled learning systems (from Figure 4-15) and (3) the results of one-on-one tutoring. The Y axis in Figure 8-1 shows the standard deviation improvement (effect size) between the treatment group and the control group.

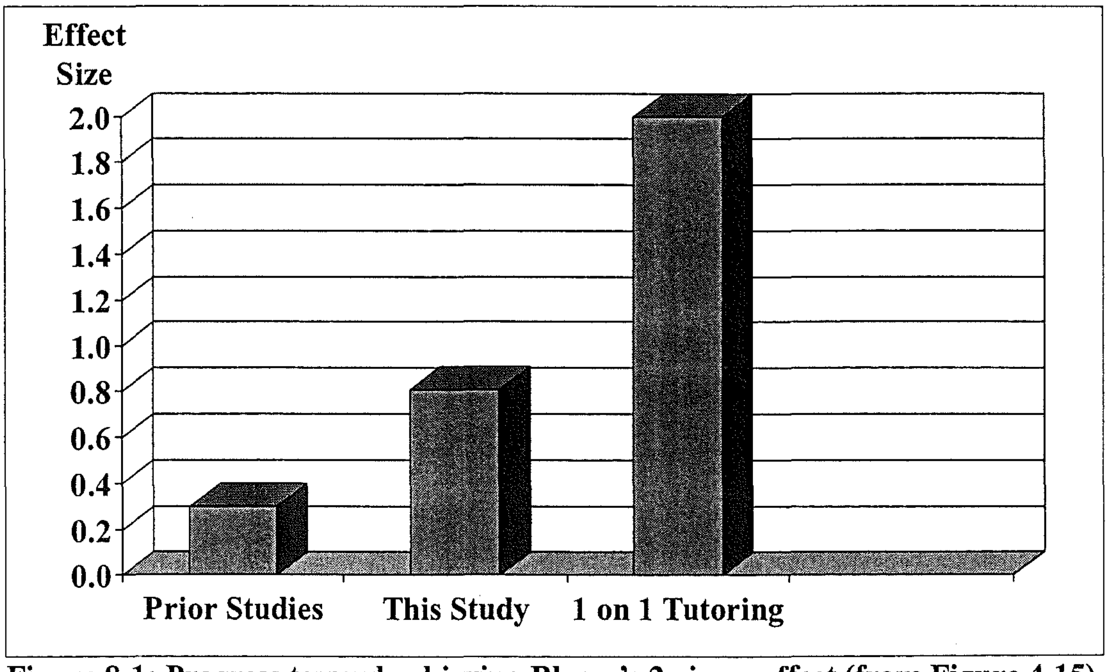

Figure 8-1: Progress toward achieving Bloom's 2-sigma effect (from Figure 4-15)

Figure 8-1 shows that prior studies have averaged approximately 0.30 effect size, this study achieved approximately 0.80 and one-on-one tutoring (the 2 sigma goal) achieves a 2.0 effect size. From this we might deduce that very real progress is demonstrated from this study, but that there is yet a long way to go.

It must be kept in mind that the results seen here are learning system differences incorporating both the technology and the learning pedagogy. This includes interactions between students and teachers. This is not simply a "high tech" effect, but rather a system effect.

Fletcher-Flinn (1995) points out that much of the positive effect shown in prior studies may be explained by the higher quality of the CAI/CAL learning materials, in comparison to traditional classroom teaching. Clarke (1994) suggests that different methods between treatment and control groups may account for improvements in results, rather than the technology differences. Both of these factors however are part of a system of learning and if used effectively with technology may have strong influence on the ability to achieve the 2-sigma effect.

If the structured effort necessary to create quality technology based learning systems is a major ingredient in gaining learning improvements then this is a characteristic to be nurtured, as it adds consistent quality of material and delivery that is hard for the average classroom teacher to match. Mass production of such quality materials could bring such systems within reach of all schools and students.

Incorporating the most effective learning methods into web based learning systems means more than just better student learning, it also provides a support for "in service" learning for the teachers as well. Teachers who are under pressure to keep up with large teaching loads, and yet want to keep up with the best learning methods could benefit from technology based learning systems built by other teachers and widely disseminated.

As international society moves toward a knowledge based economy built on the concepts of the learning society (MacFarlane, 1998; Drucker 1993; Negroponte, 1995) it is important that all socio-economic segments of society be able to participate in this emerging economic development. If technology based learning systems can achieve the 2-sigma effect, it will mean that the poor-to-average student of the traditional classroom will be able to succeed at a rate equal to the traditional classroom's best students (top 5%). This has significant ramifications for individual learning success, self-confidence and financial well being as well as national economic health. The current study has shown that Web based learning systems are capable of supporting effective learning and moving the average student up 0.80 sigma, or up to the performance of the top quartile of the traditional classroom students. This level of improvement offers very real hope that such systems can move a substantial way toward achieving Bloom's 2-sigma effect in the future.

Further progress can be hoped for as better combinations of sound pedagogy and effective technology bring such high quality learning systems within the reach of an increasing proportion of the student population, not simply the higher socio-economic strata. It is crucial in this quest to recall the words of John Dewey, "that learning is a social activity" (Dewey, 1925) so that as more effective "high-tech" learning systems are developed, they also incorporate high levels of "human touch" and don't attempt to eliminate the social aspects of learning. Incorporation of face-to-face collaboration as well as local and international learning networks of synchronous and asynchronous collaborative groups offer real prospects for supporting this "high touch" goal.

Implications of results for theory

The results described in the previous section confirm some portions of the research model (as seen in Figure 8-2) and do not support other portions. This section will discuss the modifications necessary to the original research model in the light of the study outcomes and will posit a modified model based on these changes. This will be followed by a discussion of the modified model in comparison to other theory models from the literature.

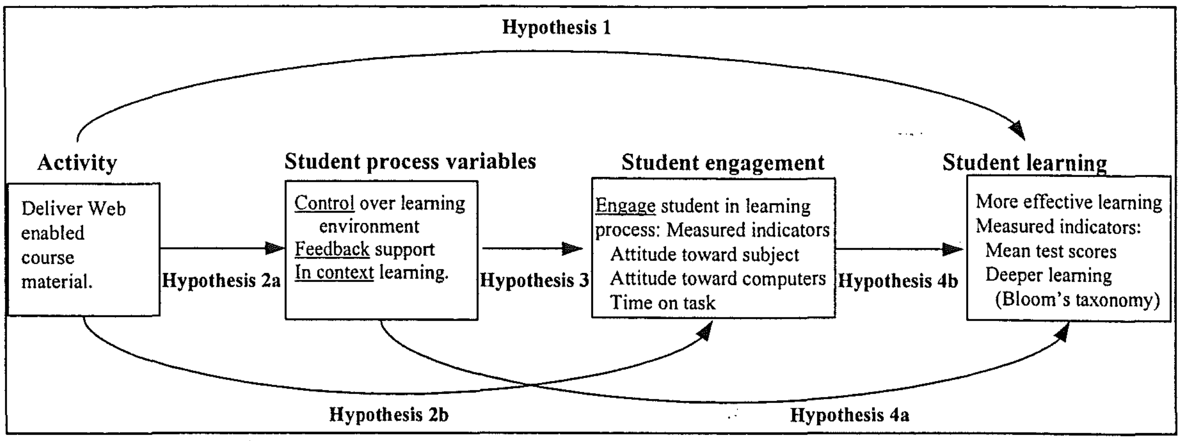

Figure 8-2: Original research model
(from Figure 3-1)

A modified research model

Figure 8-3 presents the results of this study by modifying the original research model. The modified model includes features from the original model. It also incorporates modified features of the original model, as well as new features based on the formative outcomes of this study. The fact that it is a modified model, means that some portions are untested and thus speculative. Features of the modified model (Figure 8-3) include:

- **The activity:** A web enabled learning environment that incorporates explicit design of collaborative work. The web enabled learning environment was part of this study, however the use of collaborative work is a modification that surfaced from multiple sources. Inclusion of collaborative work into the activity (treatment) and incorporation of student collaboration as an intervening variable in student learning is a new feature of the modified model. See the section below on student collaboration for support on this item.

- **Student learning:** Student learning was part of the original model, but all facets of learning were considered together with outcomes such as life long learning skills and joy of learning being treated implicitly. The outcomes of the study, especially the qualitative portions from Chapters 5 and 6, indicated that the multiple facets of student learning should be considered explicitly in multiple categories, with some learning outcomes being supported by some intervening variables and not by others (see Figure 7-4). As a result the modified theory model incorporates two components for student learning: Student learning –1 (content learning including deeper learning) and Student learning –2 (other learning factors). This allows a more clear delineation of the factors that influence the different learning outcomes.

- **Student engagement:** The impact of the web enabled learning environment on the student engagement variables was included in the original research model. However the original research model (Figure 8-2) showed both a direct link from the Activity to Student engagement (Hypothesis 2b) as well as a link from the student process variables (Hypothesis 3). This study supported Hypothesis 2b (for the subject content attitude, see Figure 7-4) but did not support Hypothesis 3, so the modified theory model has moved the Student process variable box in parallel to the Student engagement box, rather than in series. The original model also included a direct link from student engagement to student learning, this link has been retained in the modified model to Student learning –1, which includes better performance on tests and deeper learning. This link has been retained due to the strong support for Hypothesis 4b (significant at the 1% level) showing the impact attitude towards subject content had on student learning (see Figure 7-4).

- **Student collaboration:** Student collaboration is a new feature of the modified theory model. This feature has been added because during the qualitative portions of this study (Chapter 6 and portions of Chapter 5) a substantial minority of students expressed a desire for higher people contact during the computer based tutorials (see Figure 6-10 and Figure 5-13). In addition in the follow up interviews both of the better performing students had study partners, indicating that collaborative work had a benefit to student learning (see figure 6-7). Although there appears to be very little literature on collaborative learning and the Web (Schutte, 1997) there is a growing literature on collaborative learning in other settings which do support the direct implications of this study. As part of this new feature there is a hypothesised impact on both Student Learning – 1 and on Student Learning – 2.

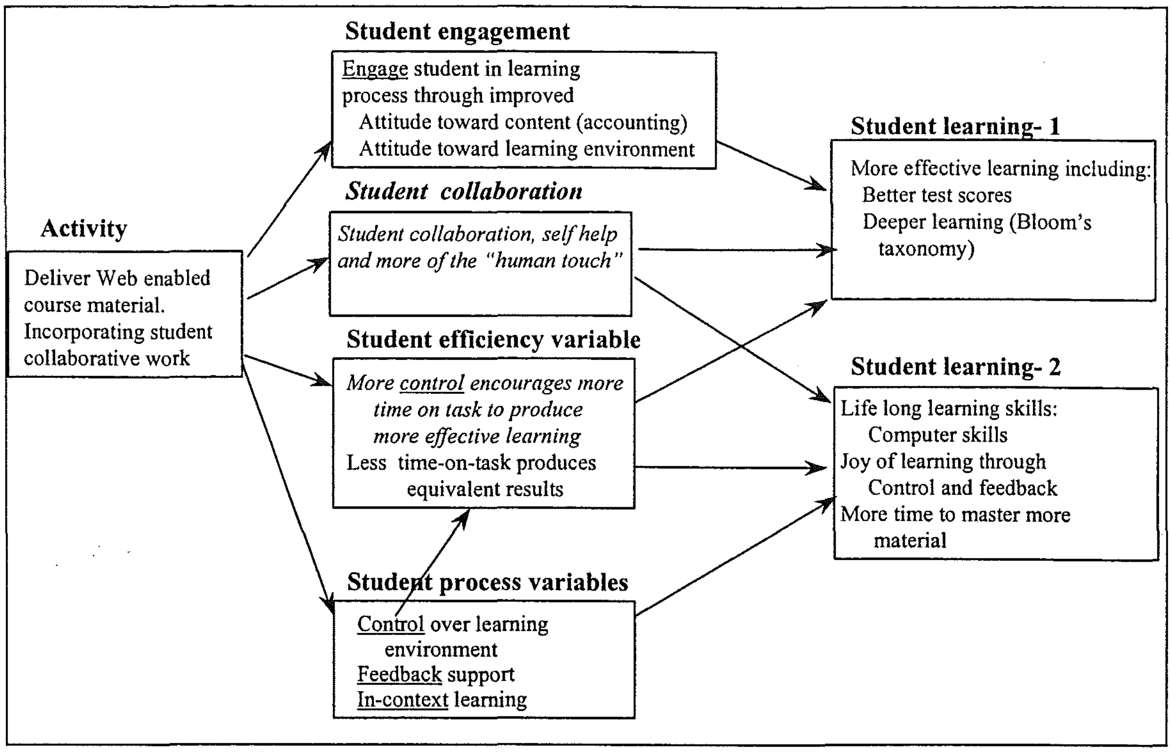

Figure 8-3: Modified theory model based on study results
(Portions in italics are new to this theory model)

- **Student efficiency variable:** Time-on-task was included in the original theory model as an engagement variable. The outcomes of this study indicated that the web enabled learning environment engendered less time-on-task, while producing better performance. As a result of this outcome time-on-task has been moved to a new feature called student efficiency in the modified model. As part of this feature it is hypothesised that the student efficiency variable will have an impact on both Student learning – 1 and Student learning – 2.

- **Student process variables:** The impact of the web enabled learning environment on the Student process variables was included in the original theory model. However the original research model showed both a direct link from the Activity to the Student process variables (Hypothesis 2a) as well as a link to the student engagement variables (Hypothesis 3). This study supported Hypothesis 2a (for the control and feedback variables, see Figure 7-4) but did not support Hypothesis 3, so the modified theory model has moved the Student engagement variable box in parallel to the Student process box, rather than in series. The original model also included a direct link from student process to student learning, this link has been retained in the modified model to Student learning –2, which includes life long learning skills and joy of learning. This link has been retained because the qualitative evidence from Chapters 5 and 6 indicated that the learning outcomes of Student learning –2 needed to be made more explicit and were supported by the process variables (see Figures 6-5, and 5-13). The modified theory model also hypothesises an impact of the control process variable on the Student efficiency variable (see the next item).

- **Student process control variable impact on student efficiency:** The impact of the Student process variable of control on the student efficiency variable of time-on-task is a new feature of the modified theory model see in Figure 8-3. This feature has been included because of the outcome from Hypothesis 3 (see Figure 7-4) which indicated the impact of control on time-on-task (significant at 10% level).

This modified theory model now reflects the outcomes of this study and can act as a foundation for future research into this important area of learning through technology based systems.

Discussion of modified model

How does this modified model compare to other models reported in the literature and used for conducting research in the area of technology supported learning systems? This section will provide an overview of each model and then compare and contrast the theoretic models with the modified theory model from the current study. These models are:

- Leidner and Jarvenpaa (1995)
- Jones and Paolucci, (1999)
- Ross and Moeller (1996)
- The current study (2001)

The Leidner and Jarvenpaa (L&J) model considers the use of Information Technology to support and deliver learning and incorporates:

- Instructional objectives aimed at aspects of the learner profile,

- Delivery system technology and design concepts,
- Learning outcomes
- Learning model used in conceptualisation of the system.

The L&J model attempts to demonstrate the interactions between the various components of the model, although being largely taxonomic in nature. This model provides a strong theoretic underpinning to the design and delivery of technology mediated learning systems and is intended to provide both a design and evaluation framework for further research in the field of educational technology..

The Jones and Paolucci (J&P) model provides a research framework for evaluating the effectiveness of technology mediated learning systems. As such their stated objective is to "identify a matrix of factors to allow researchers to identify and target specific work and ultimately contribute to more comprehensive results." Their model is fundamentally driven by instructional objectives that drive the design of the delivery system to produce specific learning outcomes. Within this broad framework the J&P model is taxonomic in nature, providing a thorough coverage of the factors impinging on each of these broad areas. There is no direct attempt to demonstrate any interactions between specific aspects of the model. This model provides an excellent coverage and theoretic foundation for evaluation and research in the field.

The Ross and Moeller (R&M) model, has a more narrow focus, concentrating on the early design stages for technology mediated learning systems, involving audience analysis (student profile), goals analysis and control analysis. As a result of this focus there is less emphasis on the delivery system and learning outcomes. The R&M model has been designed more for the technical communication professional and their needs and is less suitable for the needs of educational technology researchers. The R&M model does not attempt to demonstrate any interactions between specific aspects of the model.

Figure 8-4 presents a comparison of the characteristics of the above three models together with the characteristics of the modified theory model for the current study.

Theory Model Characteristic	L&J	J&P	R&M	Current Study
Instructional objectives				
Learning domain		✓		
Learner profile:		✓	✓	
Cognitive style	✓	✓	✓	
Aptitude and experience		✓	✓	
Education and achievement		✓	✓	
Motivation and attitude	✓	✓	✓	✓
Age and gender		✓	✓	
Task		✓	✓	
Delivery system				
Locus of control	✓	✓	✓	✓
Feedback	✓		✓	✓
Presence	✓	✓		
Place	✓	✓		
Media		✓		
Connectivity and collaboration	✓	✓	✓	✓
Ergonomics & ease of use			✓	
Classroom structure	✓			
Situated/in-context learning	✓			✓
Learning outcomes				
Cognitive skills: (along Bloom's taxonomy or other deep learning)	✓	✓		✓
Test performance	✓	✓		✓
Motivation and attitude	✓	✓		✓
Behaviour and attention	✓			
Life long learning skills				✓
Joy of learning				✓
Efficient learning				✓
Learning model: objectivist through constructivist	✓			
Causal relationships suggested	✓			✓

Figure 8-4: Comparison of four theory models' characteristics

As seen in Figure 8-4, all four models touch in some way on the purpose of the technology mediated learning system, the objectives and target of the system. However there is considerable difference in the range of coverage, with Jones and Paolucci providing the most exhaustive coverage, followed by Ross and Moeller.

Only student motivation and attitude is universally covered with student learning style covered by 3 of four models. The Leidner and Jarvenpaa model together with the modified model for the current study are weakest in the area of establishing the learning domain and consideration for the learner profile. This is a weakness of the model for the current study, if it is to be used as a comprehensive model for guiding research in the field it will need further modification and testing to incorporate these missing elements.

Regarding the delivery systems, again all four models provide some coverage of this broad characteristic, but with a reasonable amount of variation between the models. The elements of student control and collaborative learning are covered by all four models with feedback covered by three of four models. The least coverage is of the media and ergonomics issues, each only being covered by one model. The Leidner and Jarvenpaa model is the most comprehensive on the broad characteristic with the other models covering comparable proportions of the elements. The model for the current study has a reasonable coverage of the elements for the delivery system, but is weak on issues such as presence (are students and instructors in the same time or not), place (are students and instructors in the same place or not), media (choice to use text, video, audio, simulation etc.), ease of use and classroom structure (large lecture, small group, virtual classroom etc.).

Regarding learning outcomes, three of the four models provide coverage on this broad characteristic, with the Ross and Moeller model weakest in this area, providing no direct coverage of learning outcomes. Given the R&M focus on the early design (re-production) stages this is not surprising. Cognitive skills, test performance and attitude are all covered by three models, demonstrating the high level of importantce of these elements in measuring learning outcomes. This area of learning outcomes is the greatest strength of the model from the current study, covering a number of elements not touched on by the other models, including: life long learning skills, the joy of learning and efficient learning. It is interesting to note that the issue of attitude is covered both as an element to be considered in setting instructional objectives as well as in measuring learning outcomes. This issue of attitude importance was highlighted in the substantive outcomes of the current study.

In addition to the above three broad characteristics, two additional issues arise in comparing the four models: learning model and causal relationships. Explicit consideration of the learning model is incorporated only into the Leidner and Jarvenpaa model. Although all of the articles from which the models were drawn made mention of constructivist theory, only Leidner and Jarvenpaa incorporated it explicitly. In addition the issue of possible causal relationships was suggested in both the Leidner & Jarvenpaa model as well as the model for the current study. From a research standpoint this is an important factor. If causal relationships can be modelled and tested, the outcomes from such research can provide direct guidance on which characteristics and elements have most impact on learning. Such guidance can then direct the development of the most efficacious learning systems, thus making the best use of limited educational resources.

Although the outcomes of the current study are somewhat tentative due to its exploratory and formative nature, contribution to theory building, including consideration of causal relationships is an important direction for the effective development of theory and practice. As Driscol and Dick (1999) assert, it is important that formative evaluation of new learning systems be undertaken so that we know if the system is producing the anticipated results, and how to go about improving the system.

Implications of results for practice

This section covers the implications of the results from this study on the practice of higher education, especially as it relates to creating and using learning systems based on Internet technologies. These implications are largely encapsulated in the formative recommendations included in Chapter 7 (from Figure 7-5) and the modified theory model in Figure 8-3 and are discussed below under four headings: student control, student feedback, system quality and learning system effectiveness. An additional area discussed below is the implications of this study for flexible and distance learning practice.

Student control

Moving from a teacher centred learning system to a learner centred approach requires the yielding of some control from the teacher to the student. One of the most widely posited assertions in the field of educational technology and learning theory is that learner centred systems produce deeper learning and greater student motivation. (Eaton, 1996; Eklund, 1996; Laurillard, 1993; Ramsden, 1992; Entwistle, 1983). This study showed that a web enabled learning system can support higher levels of student control over the learning environment and such control encourages students to invest more time-on-task in the learning setting. The theory model (Figure 8-3) indicates that if an instructor wants students to spend more time-on-task, learn more content and experience more of the "joy of learning", then web enabled systems with strong support for student control can help achieve such goals. However, as Steinberg (1989) notes, and this study supports, improved student control does not necessarily translate into improved student performance on tests.

The qualitative portions of this study made it clear that sufficient training needed to be provided to both students and tutors at the outset of use of new web enabled learning systems if maximum benefits were to be garnered. This confirms Relan's (1995) suggestion that insufficient learner training may prevent the optimum benefits from such learning systems. Such training should include appropriate use of self paced techniques, experience with system navigation and a thorough understanding of the resources available. Ideally the training should be tailored to the background of the students and tutors to bring them up to a satisfactory level of competence in navigation and use of the learning system. Such tailored training will help maximise the student's ability to control the environment and learning experience. In addition there is a need to make all the learning resources accessible at all times. This accessibility issue can easily be addressed through a resource bar of hypertext links that is available from any point in the system.

Student feedback

Optimising appropriate feedback was highlighted as an important issue in the interviews and focus group meetings. A portion of the students felt some of the feedback was too much, making the learning too easy while others felt the feedback was too little, making the learning frustrating and too difficult. Comments like this from both sides of the spectrum indicate a need to tailor both feedback and help systems to the student's level of understanding. This outcome from the study confirms the views of Angelo and Cross (1993) and Jackson (1996) that tailored and appropriate feedback removes some of the frustration from learning, opening up the potential for improved motivation and more effective learning.

This can be accomplished through a number of different means, the best approach will depend on the discipline area and level of the course. Tailored feedback can be accomplished through a combination of "high touch" and "high tech" system elements, depending on the need of the student and the course.

High touch learning system elements can address the significant minority of students who did not like the web enabled learning environment and who wanted more people contact. This feature of the theory model (Figure 8-3) is capable of supporting deeper learning as well as more of the "joy of learning". Introduction of these elements help maintain the social learning environment urged by Dewey (1925), while still providing flexibility, rapid feedback and other benefits of the web enabled learning system. These high touch elements may include:

- The use of knowledgeable tutors in face-to-face and other synchronous settings as well as through asynchronous communication such as email, discussion forums and FAQs.

- The use of collaborative learning groups in synchronous or asynchronous settings. The work of Lim (1997) indicates that broader and deeper learning takes place in such collaborative learning settings when compared to solo learning approaches.

- The use of a "study buddy" system when working with the on-line learning system.

- Introduction of games into the learning system providing high levels of feedback, context and motivation (Rieber, 1996) including multi-user interactive games to add more social context.

High tech learning system elements for providing tailored feedback, while supporting the learning of all students, will suit particularly well the distance learning and flexible learning students who are highly motivated or under particular time pressures. These high tech elements may include:

- Incorporation of a comprehensive pre-test and post-test into the formal web learning environment as a way of providing benchmarks for students on their entry and exit points from the learning system. (Ross & Moeller 1996). Such a comprehensive pre-test and post-test regime could also be used to unearth critical misconceptions about the content area and whether the misconception had been corrected during the course (Ehrmann, 1995)

- Building on the comprehensive pre-test could be a diagnostic module which would provide students with direction on which parts of the learning system to focus on to address areas of weakness in content knowledge or application, including deep versus surface learning strategies. (Bryant & Hunton, 2000)

- Development of "intelligent tutor" sub-systems (Woolf, 1995), which provide on going correction and direction throughout the entire learning system, providing decreasing levels of assistance as the student grows in capability. Development of cognitive apprenticeship systems, similar to an intelligent tutor, is designed around student's prior knowledge, authentic learning (situated learning) scenarios, and a community-of-practice concept for presenting tutored material. (Casey, 1996)

- The use of scaffolded learning systems, which provide significant support and feedback for authentic learning activities, reducing the support as the student grows in capability. (Soloway & Prior, 1996; Jackson, 1996)

System quality

A major issue in the development of technology based course-ware is the cost of producing quality materials. Developing such materials for the web is no exception. Finding means to deliver high quality materials on limited budgets will be an ongoing challenge for many institutions (Myers, 1999). Until suitable materials are commercially available, growing your own may still be necessary. Some ways of maintaining the needed quality on a budget became evident from this study and include:

- Use of professional learning system design teams to create courses in such a way that the content can be maintained by the instructor. Appropriately designed, such course-ware may also be used as a template for more efficiently creating future courses by other teachers. (Pea et al, 1999)

- Use of standard applications to support the learning systems, rather than necessarily creating purpose built applications. The use of the Excel spreadsheet as a "helper application" in this study was an example of this. (Ehrmann, 1995; Smith, 1990)

- Use of carefully selected and well trained postgraduate and advanced undergraduate students to assist in the creation and maintenance of the system as well as providing "high touch" feedback to students.

- Actively seek student feedback on the quality of the system and utilise this feedback to update and increase the quality of materials over time.

The quality of delivery systems is also an issue in terms of reliability and response times of the systems. It is important that systems be available when they are needed and not overloaded or out of operation. It is equally important that the systems are highly responsive, yielding rapid response to learner requests.

Learning system effectiveness

A number of other factors became evident during the study which impacted on the overall effectiveness of the web enabled learning system. One of these is the potential for students to acquire considerable additional computer skills within the context of learning another discipline. This life long learning skill, shown under Student learning-2 in the theory model (Figure 8-3) is a benefit for many students that can be gained by creative inclusion of web enabled learning systems into a wide range of disciplinary contexts. Many students may see this as an additional obstacle to learning. However the increasing computer literacy demands of the work environment and life long learning requirements means there may be very real benefits to the individual's ability to access timely learning resources in the future. Their employability may demand it and benefits will accrue to them personally and to society in general. (Schreiber & Berge, 1998; Eden et al, 1996)

Interviews conducted during this study highlighted the potential benefits of considering different student learning styles and learning preferences when designing the web enabled learning environment (Bryant & Hunton, 2000; Dryden & Vos, 1993). Providing alternative ways to view material to cater to visual, auditory and kinesthetic learning styles can provide multiple supporting approaches to learning the material. This creates a richer, more real learning environment, as well as one catering to the learning needs of more students. Related to this is the design of collaborative learning features into the learning system, thus supporting the social aspects of learning and providing for natural peer-to-peer tutoring arrangements (Alavi, 1997).

Building interactivity into the learning system provides for more learning styles as well as helping to overcome the perceived boring nature of some disciplines. (Eaton, 1996; Mitrione & Rees, 1998)

Consideration must also be given to the wide range of external factors that can be crucial to student learning. To the extent that known challenges can be supported through the learning system, greater effectiveness will ensue. Some of these factors include family issues, language problems and poor self management. The web enabled environment can address some of these factors in providing flexibility to the learning schedule, thus relieving some family and time pressures. (Sangster & Lymer, 1998) Where English is a student's second language the web enabled environment can link to English language support systems and assistance thus enabling them to learn content better while improving their English at the same time. The flexible nature of the system provides further support for these second language students, permitting them to take as much time as they need to learn the material in a less threatening environment (Ehrmann, 1999). A similar provision could be made for students who find self management a challenge by providing a "time management tutor" as part of the web enabled learning system.

Distance and flexible learning issues

This study was conducted in a flexible learning setting where on-campus students were scheduled into fixed tutorial times, but were permitted to use the web enabled learning system at any time instead of attending the fixed lab time. This flexibility was welcomed by most of the participating students, with 66% of students reporting that they took advantage of this flexibility option (see Figure 5-7). The single most valuable feature of the web enabled environment, in the students' estimation, was this flexibility of timing and accessibility of the material (see Figure 5-8). This supports the issues highlighted in the literature review of Chapter 2. Issues of increasing financial pressure requiring more paid work, family pressures on mature students, and life long learning needs in the work place (Hillesheim, 1998; Boston, 1992). This appears as an essential feature of the theory model (Figure 8-3) in the control variable and is a benefit that instructors can make available to a range of students through web enabled learning systems in their disciplines.

There are however significant differences between distance learning and flexible learning settings. The flexible learning setting is fundamentally campus based providing many face-to-face opportunities in a relatively time structured environment. The distance learning student is often isolated from other students in time and space and is left to their own devices in managing the study routine. These are issues that contribute to the high drop out rate of the typical distance learning situation. (Dreyfus, 1998) This high drop out rate means wasted resources and frustration for both students and teachers. This high drop out rate is not a part of the typical flexible learning experience, perhaps due to the higher social contact and more clearly established time boundaries of campus life.

Many tertiary institutions are embarking on distance learning programmes, in part because the web looks like it will become ubiquitous and this looks like an easy way to extend the institution into new markets. However the many pitfalls of distance learning settings (high drop out rates, delivery of materials, communication channels with tutors and verification of student identity) may be overcome by greater use of flexible learning settings. Settings that include a combination of high flexibility through high tech learning systems and yet high touch contact through collaborative learning groups, mandatory campus based components and strongly moderated asynchronous communication channels.

This study demonstrated the willingness to use such settings, and effectiveness gains in terms of attitude and learning performance. An important, yet unanswered question is whether this apparent enthusiasm to use the new learning setting by many students will persist over time, and will the benefits reported in this study continue to be experienced over the longer run. This issue can only be answered by further research and is addressed under that heading later in this chapter.

Rival interpretations of the findings

In considering the outcomes of this study, it is valuable to consider rival interpretations to the findings. The major rival viewpoint would be that championed by Clark (1983, 1994): that the learning methods are the sole determiner of the effectiveness of the learning outcomes. The media used (paper, video, face-to-face or web) is simply a way of packaging or delivering the learning methods in potentially more efficient ways and cannot affect the learning outcomes. This is the "media as efficiency only" view. How does this view interpret the findings of this study and is this interpretation valid? The major outcomes of the study were:

1. The web enabled learning environment had a significant positive effect on students' attitudes towards the content being learned and this positive attitude was linked to more effective learning outcomes at both low and high levels of Bloom's taxonomy.

2. The web enabled learning environment provided effective support for higher student control and better feedback.

3. The flexibility provided by the web enabled system was an additional highly valued learning outcome.

4. There was a learning efficiency gain in the web enabled learning environment permitting students to learn at least as much for less time investment.

The "media as efficiency only" view would assert that the positive learning outcomes of this study were exclusively a result of the learning methods used, not the web enabled learning environment. However Clark admits (Ullmer, 1994) that media can have "attitude and engagement possibilities". The results of this study support the concept that the media of the web can have a significant positive impact on students' attitudes towards the content being learned. However this study then went on to demonstrate a supporting link between this positive attitude and more effective learning using both quantitative analysis and qualitative evidence. Statistically significant results were achieved at the 1% level in demonstrating the supporting chain of evidence and this was further supported by students' views on the learning survey. The most common type of comment regarding the web enabled learning environment was that it was an "Interesting and fun way to learn, enjoyable, wish all classes were this way" (Figure 5-14). This study took a systems view of the learning process where media plus methods plus students plus teachers can make significant progress toward the 2-sigma goal.

The "media as efficiency only" view on the positive student control, feedback and flexibility results would perhaps be that these are learning methods and any positive results from them are method related, not media related. This however ignores the important fact that any method must be operationalised in order to be effective, and the media fills this important role. If some media more effectively operationalise these methods, and more effective learning takes place as a result, then the media does have an impact on the effectiveness of the learning. This study demonstrated that these methods could be more effectively operationalised using a web enabled learning environment than a traditional face-to-face environment. Furthermore it must be born in mind that effective learning is not just a matter of quantum of knowledge gained, but also includes ability to progress and persist over the obstacles of time limitations and frustrations that face all learners. Higher student control, better feedback and greater flexibility may be important features in dealing with these obstacles to progress.

The "media as efficiency only" view would not be surprised at the outcome of a learning efficiency gain from using a web enabled learning environment. The interpretation would perhaps be that this is what would be hoped for, but has no bearing on effectiveness of learning. However logic would suggest that if it takes a student less time to learn material, this will free up time. This additional quantum of time could be used to learn more material, or existing material more deeply. Thus an efficiency gain could be converted into greater learning effectiveness. The challenge for future research and practice is to motivate students to carry out this learning conversion.

Limitations of study

As with all research, there are limitations that must be considered in interpreting and applying the findings of this study. The following discussion considers these limitations under two headings: (1) course and demographic limitations and (2) research design and implementation limitations. This discussion includes mitigating considerations and possible means for overcoming the limitations in future research.

Course and demographic limitations

This study was conducted with students in a first year introductory accounting course at a University in an English speaking country. Each of these factors are potential limitations on the ways in which the results of this study can be generalised. There are means to overcome these limitations by extending this research work to include other disciplines in commerce and non-commerce fields. Likewise conducting research with older and younger students, in non-English settings and non-University settings will all add to the breadth of knowledge in this area of web enabled learning. Such further studies will strengthen the ability to apply this knowledge more generally and with greater confidence.

The results of this study were based on only the tutorial portion of the first year Introductory Accounting course. All students (treatment and control groups) continued to attend the same lectures. This factor may well have a levelling effect on the results making them smaller than they would be if the entire course was web enabled. This may offset the impact of using a limited period of time (3 weeks) for the study, which the literature suggests (Kulik & Kulik, 1987) may yield higher than normal results.

This study was carried out in a campus based flexible learning environment with limited use of the email and discussion group features of the learning system. This puts some limitations on the implications that can be drawn with regard to distance learning and other asynchronous communication settings.

Research design and implementation limitations

In this study the fundamental unit of analysis was the introductory accounting course. However there were multiple embedded units of analysis including treatment group and control group, tutorial groups and individual students. Much of the descriptive statistics were based on individual student data, however all of the impact analysis was carried out with the tutorial data, since it was the tutorial groups that were randomly assigned to the treatment and control groups. The tutorial data was represented by an n of 28. This is a relatively small n for statistical purposes. If the students had been randomly assigned to treatment and control groups this would have provided an n of 159, far more robust statistically. However there are many ethical and logistics problems associated with such an exercise. This problem may be overcome by the use of quasi experimental procedures (Cook & Campbell, 1979) allowing the use of the student as the unit of analysis. This consideration is strengthened in the light of the results described by Kulik and Kulik (1987, p228) indicating that in their meta analysis of 199 comparative studies "random experiments and quasi-experiments produced the same results".

Further limitations of the research design include having two different surveys (one each for the treatment and control groups) with only some common questions. The two different surveys may raise questions about the reliability of the impact analysis regressions in comparing the treatment group to the control group. This problem is mitigated in this study in part by the fact that the common questions produced equivalent results to the composite variables, thus confirming the reliability of the procedure used.

The issue of attrition on participation rates in the study (see Figure 4-6), with a class of over 600 only producing 159 useable student records may be considered a limitation. This is in part mitigated by the fact that the attrition rates were similar for both the treatment and control groups.

Additional limitations that should be considered are theory limitations and issues related to the "honeymoon" effect. There are many other areas of theory impinging on this field of research, as evident from the fact that this study has only covered part of the Liedner-Jarvenpaa (1995) taxonomy/theory model. Media richness theory, educational psychology theories and artificial intelligence theories are just a few of the related areas of research.

The educational technology literature raises the issue of the "honeymoon" effect. This is the effect of using new technology that students find interesting at first useage, but the positive results wane over time. This concern was in part mitigated by the follow up interviews that were carried out 10 months after the experimental period, but does require further research.

Implications for future research

Research work often raises more questions than it answers, and thus the need to consider future research opportunities that were highlighted during this study. The potential future research involving web enabled learning systems that flows on from this work covers a significant range including:

- The use of quasi-experimental methods to gain a larger n while reducing the ethical and logistical issues related to such studies. Especially in the light of the work of Kulik & Kulik (1987) demonstrating that quasi-experiments in this field appear to produce equivalent results to randomly assigned experimental work.

- Further research designed around a Structural Equation Modeling (SEM) analysis approach, based on the foundational work of this study.

- Additional research on the time-on-task issue to discover more about the efficiency issues highlighted by the evidence of this study. This provides an important opportunity for converting additional available study time into effective learning, creating further progress toward the 2-sigma effect.

- Comparative studies between flexible learning (campus based) and distance learning applications of web enabled learning systems.

- Longitudinal studies carried out over longer time periods and involving full courses (rather than just a subset of a course). Such studies could involve studies over a full semester or full year with multiple measures during that time, and following those students on to further related courses. This would permit a robust response to the issue of the "Honeymoon effect" to see to what extent the impact of the web enabled system persists over time.

- Studies involving small group collaborative learning in a web enabled environment.

There is often dispute between quantitative and qualitative researchers as to which approach is best in carrying out research and measuring results. The multi-method research design used in this study demonstrated that both could be effectively integrated in carrying out research on technology based learning systems. The rich perspective gained can yield a more robust result than just a quantitative or qualitative approach.

Much more needs to be done to integrate the wide range of studies to determine the best paths to achieve the 2-sigma effect. This is a worthy goal that is capable of strongly impacting both individual lives as well as organisational and national well-being.

Summary

This study has described research conducted with a large (600+ students) first year accounting course during March-April 1998. The research focused on the impact of a web enabled learning environment on student learning, comparing the learning outcomes of students in a treatment group to those in a control group. The research used multiple methods to gain maximum insight into the learning phenomenon under consideration including: experimental, survey and qualitative work.

Major findings of the study included:

A supporting chain of evidence demonstrated in Figure 7-4 that:

- Hypothesis 1: The treatment, learning in a web enabled learning environment, had a positive impact on student learning, significant at 5% overall, 10% on Bloom's Low, but not significant on Bloom's High.

- Hypothesis 2b: The treatment, learning in a web enabled learning environment, had a positive impact on student attitude towards the subject content area (accounting), significant at the 10% level and

- Hypothesis 4b: A positive attitude towards the subject content area (accounting) had an impact on student learning for both deep and surface learning, significant at the 1% level as measured using Bloom's taxonomy for measuring depth of learning.

Additional positive outcomes included:

- Hypothesis 2a: There was a positive impact of the treatment on the students' sense of control of their learning environment and support for better feedback (significant at the 1% level).

- Hypothesis 2b: The treatment had a negative impact on time-on-task (significant at the 1% level), but students in the treatment group still outperformed the control group, indicating a strong learning efficiency gain.

- Very positive feedback from students on the use of the web enabled learning environment, especially about the anywhere/anytime flexibility and accessibility, and their enjoyment of the learning experience.

- Progress toward achieving Bloom's 2-sigma effect (where the treatment group scores 2.0 standard deviations higher than the control group) with this web mediated learning system. The students in the treatment group scored 0.80 standard deviations higher than the control group in this study.

Negative outcomes included:

- Hypothesis 4a: There was a negative impact of feedback on surface learning, as measured by the lower portion of Bloom's taxonomy (significant at 10% level).

- Hypothesis 1: Not all students enjoyed the web enabled learning environment, with a significant minority preferring more human contact in the learning process. Some students also found it frustrating trying to learn the computer environment while struggling with the course content also.

- Formative: There was a range of negative comments from students, pointing to formative recommendations involving control, feedback, quality and effectiveness of the web enabled learning systems.

A primary outcome from the study was a modified theory model (Figure 8-3), which provides a basis for further research in this important area of learning through technology based systems.

The study also considered the rival interpretations espoused by Clark viewing the media component of learning systems as simply a means of efficient delivery or packaging with no potential for learning effectiveness. This was tested and the supporting chain of evidence noted earlier provided support toward refuting this viewpoint, thus adding valuable substance to the media versus method debate.

Further value from this study was gained through the addition of a sophisticated research method to the evaluation literature and producing an early measure of web based learning.

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References

Abraham, E., Loughrey, C., Whalen, H., "Computerized practice set in introductory financial accounting", Issues in Accounting Education, Vol.2, No.1, 1987, pp.1-12

Adam, S., "Technological convergence in higher education: are the educators ready?", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.231-240

Alavi, M. and Yoo, Y., "Is learning in virtual teams real?", Harvard Business School working paper, 1997, 26 pages

Alavi, M., "Business education in the information age: Lessons from the trenches", Harvard Business School working paper, 1997, 30 pages

Alavi, M., "Computer-Mediated collaborative learning: An empirical evaluation", MIS Quarterly, June 1994, pp.159-174

Alavi, M., Wheeler, B.B. and Valcich, J.S., "Using IT to reengineer business education: an exploratory investigation of collaborative telelearning", MIS Quarterly, September 1995, pp.293-312

Alexander, S., "An evaluation of innovative projects involving communication and information technology in higher education", HERDSA, 1999, pp.173-182

Angelo, Tom and Cross, K. Patricia, Classroom assessment techniques, 2nd Edition, Jossey-Bass, 1993

Aoun, B., "Agent technology in electronic commerce and information retrieval on the Internet", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.139-149

Bearman, M., et al., "Lessons learned in publishing an electronic journal", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.253-258

Benjamin, R. and Wigand, R., "Electronic markets and virtual value chains on the information superhighway", Sloan Management Review, Winter 1995, pp.62-72

Bentler, P.M. and Wu, E.J.C., EQS for Windows – User's guide, Multivariate Software, Inc., 1995

Bentler, P.M., "Comparative fit indexes in structural models", Psychological Bulletin, 107, pp.238-246, 1990a

Bentler, P.M., "On the fit of models to covariances and methodology to the Bulletin", Psychological Bulletin, 112, pp.400-404, 1992b

Bentler, P.M., EQS for Windows – Structural Equations program manual, Multivariate Software, Inc., 1995

Biggs, J.B. and Collis, K.F., "Evaluationg the quality of learning" the SOLO taxonomy, Academic Press, New York, 1982

Biggs, J.B., Student approaches to learning and studying, Australian Council for Educational Research, 1987

Billings, D.M., "A framework for assessing outcomes and practices in web-based courses in nursing", Journal of Nursing Education, Vol.39, No.2, February 2000, pp.60-67

Bloom, B.S., "The 2 Sigma problem: The search for methods of group instruction as effective as one-to-one tutoring", Educational Research, June/July 1984, pp.4-16

Bloom, B.S., Hastings, J.T., and Madaus, G.F., Handbook on Formative and Summative Evaluation of Student Learning, New York: McGraw-Hill, 1971

Bloom, Benjamin S., ed., et al., Taxonomy of Educational Objectives: The classification of educational Goals, Handbook I: Cognitive Domain, Longmans, Green and Co., 1956, pp.207

Boalch, G., "WWW as an educational support medium: an Australian case study", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, p197-203

Borenstein, et al., "Perils and Pitfalls of practical cybercommerce", Communications of the ACM, Vol. 39, No.6, June 1996, pp. 36-44

Borras, I., "Strategy redundancy and its impact on the effectiveness of technology-enhanced instruction: a case study", The Internet and Higher Education, V.1, No. 4, 1998, pp. 263-280

Borthick, A.F., Clark, R.L., "Research on computing in accounting education: Opportunities and impediments", Issues in Accounting Education, Vol.2, No.2, 1987, pp.173-192

Boston, R.L. "Remote delivery of instruction via the PC and modem: What have we learned?", American Journal of Distance Education, 6 (3), 1992, pp.45-60

Bothun, G.D., "Distance education: Effective learning or content-free credits?", Cause/Effect, Vol.21, No.2, 1998, pp.28-31, 36-37

Bowden, J. and Marton, F., The University of Learning, Kogan Page Ltd., 1998, pp.310

Brightman, H.J., Freeman, J.L., Lewis, D., "Constructing and using computer-based formative tests", Educational Technology, June 1984, pp.36-38

Brown, G., and Atkins, M., Effective teaching in higher education, Methuen, 1988, London.

Bryant, S.M., Hunton, J.E., "The use of technology in the delivery of instruction: Implications for accounting educators and education researchers", Issues in Accounting Education, Vol.15, No.1, February 2000, pp.130-162

Byrne, Barbara M., Structural equation modelling with EQS and EQS/Windows, Sage, 1994, p.288

Bytheway, A., "Grasping the Internettle", Management Focus, April 1996 (from the Cranfield School of Management)

Campbell, D. T., and Stanley, J.C., Experimental and Quasi-Experimental Designs for Research, Houghton Mifflin, Boston, 1963

Casey, C., "Incorporating cognitive apprenticeship in multi-media", Educational Technology, Research and Development, Vol.44, No.1, 1996, pp.71-84

Cassarino, C., "Designing practice and assessment: a four-tier model", Journal of Interactive Instruction Development, pp. 14-19, Fall 1998

Cavalier, J.C., and Klein, J.D., "Effects of cooperative versus individual learning and orienting activities during computer-based instruction", Educational Technology Research and Development, Vol. 46, No. 1, 1998, pp5-17

Charp, S. "Measuring the effectiveness of educational technology." T.H.E. Journal, Vol 25, No. 7, 1998.

Chen, H.T., Theory-driven Evaluations, Sage Publications, Newbury Park, 1990

Chin, W.W., "Issues and opinion on Structural Equation Modeling", MIS Quarterly, March 1998, vii-xvi

Choi, J.I., Hannafin, M., "Situated cognition and learning environments: Roles, structures, and implications for design", Educational Technology, Research and Development, Vol.43, No.2, 1995, pp.53-69

Clark, R.E., "Media will never influence learning", Educational Technology, Research and Development, Vol. 42, No. 2, 1994, pp.21-29

Clark, R.E., "Reconsidering research on learning from media", Review of Educational Research, Winter 1983, Vol. 53, No. 4, pp. 445-459

Cook, E.K., and Kazlauskas, E.J., "The cognitive and behavioural basis of an instructional design: Using CBT to teach technical information and learning strategies", Journal of Educational Technology Systems, Vol. 21, No. 4, pp 287-302, 1993

Cook, T.D., and Campbell, D.T., Quasi-Experimentation: Design and Analysis Issues for Field Settings, Rand McNally, Chicago, 1979

Cookman, C., "A computer-based graphics course and students' cognitive skills", Journalism & Mass Communication Educator, Autumn 1998, pp. 37-49

Cox, Kevin, and Clark, David, "The use of formative quizzes for deep learning", Computers in Education, Vol 30, No.3/4, pp. 157-167, 1998

Crooks, S.M., Klein, J.D., Savenye, W., Leader, L., "Effects of cooperative and individual learning during learner-controlled computer-based instruction", The Journal of Experimental Education, Vol.66, No.3, 1998, pp.223-244

Daroca, F.P., Nourayi, M.M., "Some performance and attitude effects on students in managerial accounting: Lecture vs. self-study courses", Issues in Accounting Education, Vol.9, No.2, Fall 1994, pp.319-327

Debreceny, R.S., Smith, G.S., White, C.E., Lymer, A., Priest, A., "Accounting education and the Internet: a second and closer look", Proceedings of the 11th Asian-Pacific Conference on International Accounting Issues, 1999

DeJesus, E. X., "How the Internet will replace broadcasting", Byte, February, pp51-64, 1996

Delcourt, M.A., and Kinzie, M.B., "Computer technologies in teacher education: The measurement of attitudes and self-efficacy,", Journal of Research and Development in Education, Vol. 27, pp35-41., 1993

Dewey, John, Experience and nature, Open Court Publishing Company, Chicago, 1925

Dillon, A., Gabbard, R., "Hypermedia as an educational technology: A review of the quantitative research literature on learner comprehension, control, and style", Review of Educational Research, Vol.68, No.3, Fall 1998, pp.322-349

Dreyfus, H.L., "Education on the Internet: anonymity versus commitment", The Internet and Higher Education, V.1, No. 2, 1998, pp. 113-129

Drucker, P.F., Post-Capitalist Society, Harper Business, 1993

Dryden, G., and Vos, J., The Learning Revolution, Profile books, Auckland, 1993, pp.512

Duffy, T.M. and Jonassen, D.H., Editors. Constructivism and the technology of instruction: A conversation, Lawrence Erlbaum Associates, 1992, pp.221

Eaton, M., "Interactive features of HTML-based tutorials in distance learning programs", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.309-312

Eden, H., Eisenberg, M., Fischer, G., and Repenning, R., "Making learning a part of life", Communications of the ACM, Vol. 39, No. 4, April 1996, pp. 40-42

Ehrmann, S.C., "Asking the hard questions about technology use and education", Change, March/April 1999, pp.25-29

Ehrmann, S.C., "Asking the right questions: What does research tell us about technology and higher learning", Change, March/April 1995, pp.20-27

Eklund, J., and Eklund, P., "Integrating the Web and the teaching of technology: cases across two universities", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.357-361

Ells, R., "Effective use of the web for education: Design principles and pedagogy", A workshop given at the Professional and Organizational Development Network in Higher Education conference in Haines City, Florida, University of Washington, October 16-19, 1997, 38 pages. See also [HREF 6]

Entwistle, N. and Ramsden, P. Understanding student learning, Croom Helm, 1983

Entwistle, N.J. and Brennan, T. "The academic performance of students", British Journal of Educational Psychology, Vol 41, pp. 268-276, 1971

Evans, C., "Improving test practices to require an evaluation of higher levels of thinking", Education, Chula Vista, Vol. 119, No. 4, pp. 616-618, 1998.

Evans, R.M., Murray, S.L., Daily, M., Hall, R., "Effectiveness of an internet-based graduate engineering management course", Journal of Engineering Education, January 2000, pp.63-71

Faux, T.L, Black-Hughes, C., "A comparison of using the internet versus lectures to teach social work history", Research on Social Work Practice , Vol.10, No.4, July 2000, pp.454-466

Fletcher-Flinn, C.M. and Gravatt, B., "The efficacy of computer assisted instruction (CAI):A meta-analysis", Journal of Educational Computing Research, 1995, Vol.12, No.3, pp.219-242

Galegher, J., and Kraut, R.E., "Computer mediated communication for intellectual teamwork: an experiment in group writing", Information Systems Research, V.5, no. 2, June 1994, pp.110-139

Geerts, G. and Waddington, B., "An interactive Internet tool for learning in accounting information systems", a working paper, Michigan State University, March 1998

Gierl, M.J., "Comparing cognitive representations of test developers and students on a mathematics test with Bloom's Taxonomy", Journal of Educational Research, Vol.91, No.1, 1997, pp.26-32

Gilbert, C., "Teaching and learning on the Web at Queensland University of Technology", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, p.225-229

Gilliver, R.S., "Net-accounting: Using the WWW to learn accounting", un-published working paper presented for the October1997 CTI series at Ngee Ann Polytechnic, Singapore

Gressard,C.O. and Loyd, B.H., "Validation studies of a new computer attitude scale", Association for Educational Data Systems Journal, Vol. 18, No. 4, 1986, pp. 295-301.

Griswold, P.A., "Some determinants of computer awareness among education majors", Association for Educational Data Systems Journal, Vol 16, No. 2, 1983, pp. 92-103

Guzdial, M., et.al. "Computer support for learning through complex problem solving", Communications of the ACM, Vol. 39, No. 4, April 1996, pp. 43-45

Hamalainen, M., Whinston, A.B. and Vishik, V., "Electronic markets for learning: education brokerages on the Internet", Communications of the ACM, June 1996, Vol. 39, No. 6, pp.51-58

Hammersley, M., ed., Case studies in Classroom research, Open University Press, 1986

Harasim, L. "On-line education: a new domain", pp. 50-62, in Mason, R. and Kaye, A., "Mindweave, communication, computers and distance education", Pergamon Press, Oxford UK, 1989, p.260

Harcourt, Brace and World, the Standard College Dictionary, 1963, Funk & Wagnalls Company

Harrell, W.L. Jnr., "Productivity tool and cognitive simulator", Journal of Educational Computing Research, Vol.22, No.1, 2000, pp.75-104

Harris, M.H., "Is the revolution now over, or has it just begun?", The Internet and Higher Education, Vol.1, No.4, 1998, pp. 243-251

Harris, P.C., Harris, M.H. and Hannah, S.A. "Confronting hypertext: exploring divergent response to digital coursework", The Internet and Higher Education, Vol.1, No.1, 1998, pp.45-57

Hillesheim, G., "Distance learning: barriers and strategies for students and faculty", The Internet and Higher Education, Vol.1, No.1, 1998, pp.31-44

Hirumi, T., Savenye, W., Allen, B., "Designing interactive videodisc-based museum exhibits: a case study" Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 47-55

Houldsworth, E. and Hawkbridge, D., "Technology based training in large UK companies: An update", British Journal of Educational Technology, 1996, Vol.27, No.1, pp.51-60

Hutchison, C., "Distance learning on the Internet", Journal of Computer Mediated Communication, note to the "ICP OnLine" article, Vol.1, No.1, 1995b

Hutchison, C., "The 'ICP OnLine': jeux sams frontieres on the cyber campus", Journal of Computer Mediated Communication, Vol.1, No.1. 1995a

Imrie, Bradford W. "Assessment for learning: quality and taxonomies", Assessment & Evaluation in Higher Education, Vol. 20, No. 2, pp. 175-189, 1995.

Ives, B. and Jarvenpaa, S., "Electronic commerce on the WWW, a case study", 1994

Ives, B., "The Internet, the Web and the Academic: how some move and why some do not", Proceedings of the 4th European Conference on Information Systems, 1996

Ives, B., and Jarvenpaa, S.L., "Will the Internet Revolutionize business education and research", Sloan Management Review, Spring 1996, pp.33-41

Jackling, B., Students' motives, strategies and perceptions in studying financial accounting: Implications for quality learning outcomes, Accounting Association of Australia and New Zealand 1999 Conference.

Jackson, S.L., Stratford, S.J., Krajcik, J., and Soloway, E., "A learner-centered tool for students building models", Communications of the ACM, Vol.39, No. 4, April 1996, pp. 48-49

Jensen, E., Brain-based learning, Turning Point Publishing, Del Mar, 1996, pp. 373

Jonassen, D.H., Campbell, J.O., and Davidson, M.E., "Learning with media: restructuring the debate" Educational Technology, Research and Development, Vol.42, No.2, 1994, pp. 31-39

Jonassen, D.H., Carr, C., Yueh, H.P., "Computers as mindtools for engaging learners in critical thinking", Techtrends, March 1998, pp.24-32

Jones, D., "Solving some problems of University Education: a case study", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.243-252

Jones, T.H., Paolucci, R., "Research framework and dimensions for evaluating the effectiveness of educational technology systems on learning outcomes", Journal of Research on Computing in Education, Vol.32, No.2, 1999, pp.17-27

Kashy, E., Thoennessen, M., Tsai, Y., Davis, N.E., and Wolfe, S.L., "Using networked tools to promote student success in large classes", Journal of Engineering Education, October 1998, pp.385-390

Kernan, W.C., and Howard, G.S., "Computer anxiety and computer attitudes: An investigation of construct and predictive validity issues", Educational and Psychological Measurement, Vol. 50, No. 3, Autumn 1990, pp. 681-690

King, W.R., Premkumar, G. and Ramamurthy, K., "An evaluation of the role and performance of a decision support system in business education", Decision Sciences, 1990, Vol.21, pp.642-659

Kozma, R., "Reflections on the state of educational technology research and development", Educational Technology, Research and Development, Vol.48, No.1, 2000, pp.5-15

Kozma, R.B., "Will media influence learning? Reframing the debate" Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 7-19

Krendl, K.A. and Lieberman, D.A., "Computers and learning: A review of recent research", Journal of Educational Computing Research, 1988, Vol.4, pp.367-389

Kulik, J.A. and Kulik, C.L., "Review of recent research literature on computer-based instruction", Contemporary Educational Psychology, 1987, Vol.12, pp.222-230

Kulik, J.A., Kulik, C.C. and Cohen, P.A., "Effectiveness of computer-based college teaching: A meta-analysis of findings", Review of Educational Research, Winter 1980, Vol.50, No.4, pp.525-544

Lampe, C. J., Conover, W.J., and Sutton, S.G., "Uses and misuses of Cronbach's Alpha: implications for behavioural researchers", Accounting Association of Australia and New Zealand, 1999 Conference

Larsen, R. E., "Relationship of learning style to the effectiveness and acceptance of interactive video instruction," Journal of Computer Based Instruction, Vol. 19, No. 1, 1992, pp.17-21.

Laurillard, D., "Multimedia and the changing experience of the learner", British Journal of Educational Technology, Vol.26, No.3, 1995, pp.179-189

Laurillard, D., Rethinking university teaching, Routledge, 1993

Leidner, D.E., and Jarvenpaa, S.L., "The information age confronts education: case studies on electronic classrooms", Information Systems Research 4:1, March 1993, pp.24-54

Leidner, D.E., and Jarvenpaa, S.L., "The use of information technology to enhance management school education: a Theoretical view", MIS Quarterly, September 1995, pp.266-291

Levinson, P., "Media relations: integrating computer telecommunications with educational media", p.40-49 in Mason, R. and Kaye, A., "Mindweave, communication, computers and distance education", Pergamon Press, Oxford UK, 1989, p.260

Lim, K.H., Ward, L.M. and Benbasat, I., "An empirical study of computer system learning: Comparison of co-discovery and self-discovery methods", Information Systems Research, Vol.8, No.3, September 1997, pp.254-272

Lockee, B.B., Burton, J.K., Cross, L.H., "No comparison: Distance education finds a new use for 'No significant difference'", Educational Technology, Research and Development, Vol.47, No.3, 1999, pp.33-42

MacDonald, C.J., and Gabriel, M.A., "Toward a partnership model for Web-based learning", The Internet and Higher Education, Vol.1, No.3, 1998, pp. 203-216

MacFarlane, A. and University, H.W., "Information, knowledge and learning", Higher Education Quarterly, 1998, Vol.52, No.1, pp.77-92

Mason, R., "An evaluation of CoSy on an Open University course" p.115-145, in Mason, R. and Kaye, A., "Mindweave, communication, computers and distance education", Pergamon Press, Oxford UK, 1989, p.260

Massoud, S.L., "Computer attitudes and computer knowledge of adult students", Journal of Educational Computing Research, Vol 7, No. 3, 1991, pp.269-291

McAlpine, Iain, "A qualitative study of learning from CAL programs in two tertiary education courses" a Research Report in the ERIC database, 6 pages, 1996

McClave, J.T., Dietrich, F.H., and Sincich, T., Statistics, 7th Edition, Prentice-Hall International, Inc. 1997, pp.823

McLuhan, M., The Gutenberg Galaxy: the making of typographical man, Routledge and Kegan, London, 1962, p. 294

Mehta, S., and Schlecht, N.W., "Computerized assessment technique for large classes", Journal of Engineering Education, April 1998, pp.167-172

Michalko, M., Thinkertoys, Ten Speed Press, 1991, pp.355

Mitrione, L., Rees, K., Professional education for accounting graduates: The use of computer-assisted learning (CAL) in developing accounting competencies, Deakin University, Working paper, 1998

Mohr, L. B., "The case study as a research design in social science", proceedings of World Association of Case Research and Application (WACRA), 1995a

Mohr, L.B. Impact Analysis for Program Evaluation, Sage Publications, 1995b

Mohr, L.B., "Causation and the case study", a working paper (1996), an earlier version delivered at the World Association of Case Research and Application (WACRA), 1992

Montazemi, A.R., Wang, F., "An empirical investigation of CBI in support of mastery learning", Journal of Educational Computing Research, Vol.13, No.2, 1995, pp.185-205

Moore, G.A., Crossing the Chasm: Marketing and selling technology products to mainstream customers, HarperBusiness, a Division of HarperCollins Publishers, 1991

Morrison, G.R., "The media effects question: 'unresolvable' or asking the right question" Educational Technology, Research and Development, Vol.42, No.2, 1994, pp. 41-44

Muller, N.J., "Multimedia over the network", BYTE, March 1996, pp. 73-82

Myers, Kenneth L., "Is there a place for instructional design in the information age", Educational Technology, November-December 1999, pp. 50-53.

Navassardian, S., Marinov, M., Pavlova, R., "Investigations on the quality and efficiency of instructive computer-aided training", British Journal of Educational Technology, Vol.26, No.2, 1995, pp.109-121

Negroponte, N., Being Digital, Hodder & Stoughton, Rydalmere NSW, 1995

Nevis, E.C., DiBella, A.J., and Gould, J.M., "Understanding Organizations as Learning Systems", Sloan Management Review, Winter 1995, pp.73-85

Nguyen, A.T.A., Tan, W., Kezunovic, L., "Interactive multimedia on the WWW: implementation and implications for the tertiary sector", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996b, pp.551-557

Nguyen, T.L., "Network performance – impact on networked educational software", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996a, pp.281-286

Nipper, S. "Third generation distance learning and computer conferencing", pp. 63-73, in Mason, R. and Kaye, A., "Mindweave, communication, computers and distance education", Pergamon Press, Oxford UK, 1989, p.260

Norman, D.A., and Spohrer, J.C., "Learner-centered education", ", Communications of the ACM, Vol.39, No.4, April 1996, pp. 24-27

Norris, C.M., and Lundsen, B., "Functional distance and the attitudes of educators towards computers", Technological Horizons in Education Journal, No. 11, 1987, pp. 129-132.

Nunnally, Jum C., Psychometric Theory, 2ed, McGraw-Hill, 1978

O'Connor, Sean, "Interactive teaching workshop, engaging students in education", unpublished, 1996

O'Reilly, T., "Publishing models for Internet Commerce", Communications of the ACM, Vol 39, No. 6, June 1996, pp. 79-86

Oliver, R. and Omari, A., "The place of the WWW in an undergraduate multimedia degree program", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.293-297

Paolucci, R., "The effects of cognitive style and knowledge structure on performance using a hypermedia learning system", Journal of Educational Multimedia and Hypermedia, Vol. 7, No. 2-3, 1998, pp.123-150.

Papa, F., Perugini, M. and Spendaletti, S., "Psychological factors in virtual classroom situations: A pilot study for a model of learning through technological devices", Behavior & Information Technology, 1998, Vol.17, No.4, pp.187-194

Parker, C. and Swatman, P., "TREAT: designing a teaching simulation environment", Monash University Working Paper 29/95, 1995a

Parker, C.M. Swatman, P.M., Petric, D and Gricar, J., "The Curtin/Maribor EDI simulation, an innovative approach to teaching international telecommunications", The Seventh International Conference on Electronic Data Interchange and Interorganizational Systems, Bled, Slovenia, June 1994.

Parker, Craig and Swatman, Paula, "Laboratory-based electronic commerce: a comparison of technical and business oriented student experiences", Monash, Department of Information Systems working paper 31/95, 1995b.

Pea, R.D., Taker, R., Linn, M., Means, B., Bransford, J., Roschelle, J., Hsu, S., Broohy, S., and Songer, N., "Toward a learning technologies knowledge network", Educational Technology Research and Development, Vol. 47, No. 2, 1999, pp. 19-38.

Pennel, R. "Managing online learning", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, p.315-320

Pitkow, J.E., and Kehoe, C.M., "Emerging trends in the WWW user population", Communications of the ACM, Vol.39, No.6, June 1996, pp. 106-108

Ramsden, P., Learning To Teach In Higher Education, Routledge Publishing,, London, pp269, 1992

Reece, M.J., and Gable, R.K., "The development and validation of a measure of general attitudes toward computers", Educational and Psychological Measurement, No. 42, 1982, pp. 913-916

Reiser, R.A., "Clark's invitation to the dance: an instructional designer's response" Educational Technology, Research and Development, Vol.42, No.2, 1994, pp. 45-48

Relan, A., "Promoting better choices: Effects of strategy training on achievement and choice behavior in learner-controlled CBI", Journal of Educational Computing Research, Vol.13, No.2, 1995, pp.129-149

Rieber, L.P., "Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games", Educational Technology, Research and Development, Vol.44, No.2, 1996, pp. 43-58

Ross, S., Moeller, E.W., "Multimedia and hypermedia CBI: A multidisciplinary review of research on early design stages", Journal of Business and Technical Communication, Vol.10, No.4, October 1996, pp.428-460

Rosson, M.B., and Carroll, J.M., "Scaffolded examples for learning object-oriented design", Communications of the ACM, Vol.39, No.4, April 1996, pp. 46-47

Roufaiel, N.S., "Electronic tutor: A tool for financial accounting education", Issues in Accounting Education, Vol.3, No.1, 1988, pp.181-198

Rowntree, D., "Teaching and learning online: a correspondence education for the 21st century?", British Journal of Educational Technology, 1995, Vol.26, No.3, pp.205-215

Rudy, I.A., "A critical review of research on email", European Journal of Information Systems (1996) 4, pp. 198-213

Rumble, G., "On-line costs, interactivity at a price", p146-165, in Mason, R. and Kaye, A., "Mindweave, communication, computers and distance education", Pergamon Press, Oxford UK, 1989, p.260

Rutherford, P., "Annotations: the key to collaborative teaching and learning on the Internet", Proceedings of the Second Australian WorldWideWeb Conference, AusWeb, 1996, pp.331-334

Sangster, A. and Lymer, A., "Internet technology and accounting education: A new era?", 21st EAA Congress, Antwerp, Belgium, April 6-8th, 1998

Sangster, A., Lymer, A., "How to survive a new educational era", Issues in Accounting Education, Vol.13, No.4, November 1998, pp.1095-1109

Scardamalia, M. and Bereiter, C. "Student communities for the advancement of knowledge", Communications of the ACM, Vol.39, No.4, April 1996, pp. 36-37.

Schank, R.C. and Kass, A., "A goal-based scenario system", Communications of the ACM, Vol.39, No.4, April 1996, pp. 28-29.

Schreiber, D. A., and Berge, Z.L., ed., Distance Training, Jossey-Bass, 1998, pp. 441

Schutte, J.G., "Virtual teaching in higher education: The new intellectual superhighway or just another traffic jam?", 1997, http://www.csun.edu/sociology/virexp.htm

Shneiderman, B., Borkowski, E.Y., Alavi, M., Norman, K., "Emergent patterns of teaching/learning in electronic classrooms", Educational Technology, Research and Development, Vol.46, No.4, 1998, pp.23-42

Shrock, S.A., "The media influence debate: read the fine print, but don't lose sight of the big picture" Educational Technology, Research and Development, Vol.42, No.2, 1994, pp. 49-53

Simpson, M., "Neurophysiological considerations related to interactive multimedia" Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 75-81

Smith, A., "More ways of teaching more people more effectively? Developing technologies and the issues for management development", Proceeding of WACRA, 1996.

Smith, K.L., "Collaoratiive and interactive writing for increasing communication skills," Hispania, Vol. 73, No.1, 1990, pp.77-87

Soloway, E. and Pryor, A. "The next generation in human-computer interaction", Communications of the ACM, Vol.39, No.4, April 1996, pp.16-18. 1996

Soloway, E., "Teachers are the key", Communications of the ACM, Vol.39, No.6, June 1996, pp.11-14. 1996

Sponder, B., and Hilgenfeld, R., "Cognitive guidelines for teachers developing computer-assisted instruction", The Computing Teacher, pp. 9-15, November 1994

Stair, R.M., and Reynolds, G.W., Principles of Information Systems: a Managerial Approach, 3rd Edition, Course Technology, 1998, pp. 672.

Steinberg, E. "Cognition and learner control: A literature review", Journal of Computer-Based Instruction, Vol 18, No. 4, 1989, pp. 117-121

Stevens, D.J., "How educators perceive computers in the classroom", Association for Educational Data Systems Journal, Spring 1980, pp. 221-232

Stohr, E., "Introduction to special issue on IS curricula and pedagogy", MIS Quarterly, September 1995

Traub, R.E., Reliability for the Social Sciences: Theory and Application, Sage Publications, Thousand Oaks, 1994

Ullmer, E.J., "Media and learning: are there two kinds of truth?", Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 21-32

Usova, G.M., "Effective test item discrimination using Bloom's taxonomy", Education, Chula Vista, Vol. 118, No. 1, pp.100-111, 1997

Wheeler, B.C., Valacich, J.S., Alavi, M. and Vogel, D., "A framework for technology-mediated inter-institutional telelearning relationships", Journal of Computer Mediated Communication, Vol.1, Issue 1, 1995

Whitehead, A.N., The aims of education and other essays, Williams and Northgate Ltd., London, 1929, pp. 247

Woodrow, J.E.J., "A comparison of four computer attitude scales", Journal of Educational Computing Research, Vol 7, No. 2, 1991, pp. 165-187

Woolf, B.P. and Hall, W., "Multimedia pedogogues: interactive systems for teaching and learning, IEEE Computer, May 1995, pp. 74-80

Woolf, B.P., "Artificial Intelligence in Education", Encyclopedia of Artificial Intelligence, 2nd Edition, 1992, pp.434-444

Woolf, B.P., "Intelligent multimedia tutoring systems", Communications of the ACM, Vol.39, No.4, April 1996, pp. 30-31

Yin, R.K., Case study research, design and methods, Sage Publishing, pp. 171, 1994

Yunker, B.D., "Adding authenticity to traditional multiple choice test formats", Education, Chula Vista, Vol. 120, No. 1, pp. 82-87, 1999

Zakrzewski, S., Steven, C., "A model for computer-based assessment: The catherine wheel principle", Assessment & Evaluation in Higher Education, Vol.25, No.2, 2000, pp.201-215

Zhang, Y., Espinoza, S., "Relationships among computer self-efficacy, attitudes toward computers, and desirability of learning computing skills", Journal of Research on Computing in Education, Vol.30, No.4, Summer 1998, pp.420-436

Hypertext References

HREF 1

http://www.afis.canterbury.ac.nz/mediacase/wwwcase.htm - Harlequin Multimedia Case

HREF 2

http://ausweb.scu.edu.au/proceedings/vargo/paper.html

HREF 3

http://www1.afis.canterbury.ac.nz/

HREF 4

http://www.acs.ucalgary.ca/~newsted/surveys.html

HREF 5

http://mofetsrv.mofet.macam98.ac.il/~elaine//eti/welcome.htm

HREF 6

http://staff.washington.edu/rells/pod97/index.html

Bibliography

Readings not referenced directly in the thesis

Alan, R.J., "Who had better be on first: Getting optimal results from multimedia training", The McGraw-Hill Handbook, 1994, Chapter 13

Arnone, M.P., Grabowski, B.L., Rynd, C.P., "Curiosity as a personality variable influencing learning in a learner controlled lesson with and without advisement", Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 5-20

Asher, H.B., Casual modeling, Sage Publications, Inc, 1976

Astleitner, H., Leutner, D., "Learning strategies for unstructured hypermedia – A framework for theory, research, and practice", Journal of Educational Computing Research, Vol.13, No.4, 1995, pp.387-400

Atkinson, M.A., Kydd, C., Individual characteristics associated with World Wide Web use: An empirical study of playfulness and motivation", The DATA BASE for Advances in Information Systems, Vol.28, No.2, 1997, pp.53-62

Azevedo, R., Bernard, R.M., "A meta-analysis of the effects of feedback in computer-based instruction", Journal of Educational Computing Research, Vol.13, No.2, 1995, pp.111-127

Bailey, C., Chambers, J., "Interactive learning and technology in the US science and mathematics reform movement", British Journal of Educational Technology, Vol.27, No.2, 1996, pp.123-133

Bajwa, D.S., Rai, A., Brennan, I., "Key antecedents of executive information system success: A path analytic approach", Decision Support Systems, Vol.22, 1998, pp.31-Bartolacci, M., "Intergration of the World Wide Web and teaching: A work in progress", OR/MS Today, October 1996, pp.46-48

Beggs, I., "Issues and trends in the UK Higher Education System: The case of the University of the Highlands and Islands (UHI)", Systemist, Vol.19, No.1, 1997, pp.37-44

Bentler, P.M., Chou, C.P., "Practical issues in structural modeling", Sociological Methods & Research, Vol.16, No.1, August 1987, pp.78-117

Bentler, P.M., Dudgeon, P., "Convariance structure analysis: Statistical practice, theory, and directions", Annual Review of Psychology, Vol.47, 1996, pp.563-592

Chan, Y.E., Huff, S.L., Barclay, D.W., Copeland, D.G., "Business strategic orientation, information systems strategic orientation, and strategic alignment", Information Systems Research, Vol.8, No.2, 1997, pp.125-150

Chin, W., Methodological Alternatives to SEM/CFA, http://www.gsu.edu/~mkteer/relmeth.html

Chin, W.W., On the use and reporting of covariance-based structural equations models in assessing survey research, http://www.acs.ucalcary.ca/~chin/surv.html,

Clark, R.E., "Media and method", Educational Technology, Research and Development, Vol.42, No.3, 1994, pp. 7-10

Cloke, C., Farren, M., Barrington, J., "Interactive video and group learning: Two action enquiry based evaluations", British Journal of Educational Technology, Vol.27,Darke, P., Shanks, G., Broadbent, M., "Successfully completing case study research: Combining rigour, relevance and pragmatism", Information Systems Journal, Vol.8, 1998, pp.273-289

Driscoll, M.P., Dick, W., "New research paradigms in instructional technology: An inquiry", Educational Technology, Research and Development, Vol.47, No.2, 1999, pp.7-18

Duffy and Jonassen, Constructivism and the Technology of Instruction, LEA, LB 1028.38 .C764

Fornell, C., Bookstein, F.L., "Two structural equation models: LISREL and PLS applied to consumer Exit-Voice Theory", Journal of Marketing Research, Vol.19, Nov 1982, pp.440-452

Garson, G.D., The role of technology in quality education, http://hcl.chass.ncsu.edu/sscore/garson2.htm, 1999

Gassenheimer, J.B., Calantone, R.J., Schmitz, J.M., Robicheaux, R.A., "Models of channel maintenance: What is the weaker party to do?", Journal of Business Research, Vol.30, 1994, pp.225-236

Gerlach, K., "The virtual classroom - A business necessity", The McGraw-Hill Multimedia Handbook, 1994, Chapter 6

Hardaway, D., Will, R.P., "Multimedia PC-based technology: Opportunity for an expanded educational format", Interface, Vol.14, No.4, 1992, pp.21-24

Holden, E., McClanahan, A., Perotti, V., "Learning styles of MIS majors in a college of business administration", Interface, Vol.15, No.2, 1993, pp.16-21

Hoy and Miskel, Educational Administration: Theory, Research and Practice, LB 2805 .H867

Ives, B., Olson, M.H., Baroudi, J.J., "The measurement of user information satisfaction", Communications of the ACM, Vol.26, No.10, October 1983, pp.785-793

Johnsen, S., "How would you code your questions", Gifted Child Today Magazine, Vol.23, No.2, 2000, start page.5

Jonassen, Editor, Handbook of Research For Educational Communication and Technology, LB 1028.3 .H236, MacMillan Publishing

Jones, A., Appendix A: The survey instrument, PhD Thesis

Jones, A., Chapter 4: Data analysis and results, PhD Thesis

Kaplan, D., Statistical power in structural equation models, http://www.gsu.edu/~mkteer/power.html

King, K.S., Boling, E., Annelli, J., Bray, M., Cardenas, D., Frick, T., "Relative perceptibility of hypercard buttons using pictorial symbols and text labels", Journal of Educational Computing Research, Vol.14, No.1, 1996, pp.67-81

Kinzie, M.B., Larsen, V.A., Burch, J.B., Boker, S.M., "Frog dissection via the world-wide web: Implications for widespread delivery of instruction", Educational Technology, Research and Development, Vol.44, No.2, 1996, pp. 59-69

Klass, G., Crothers, L., "An experimental evaluation of web-based tutorial quizzes", Social Science Computer Review, Vol.18, No.4, Winter 2000, pp.508-515

Knight, B.A., Knight, C., "Cognitive theory and the use of computers in the primary classroom", British Journal of Educational Technology, Vol.26, No.2, 1995, pp.141-148

Knutson, C.D., "State of the art: Building the model network", Byte, October 1996, pp.101-104

Koumi, J., "Media comparison and deployment: A practitioner's view", British Journal of Educational Technology, Vol.25, No.1, 1994, pp.41-57

Kozma, R.B., "A reply: Media and methods", Educational Technology, Research and Development, Vol.42, No.3, 1994, pp. 11-14

Kumar, D.D., Helgeson, S.L., White, A.L., "Computer technology-cognitive psychology interface and science performance assessment", Educational Technology, Research and Development, Vol.42, No.4, 1994, pp.6-16

Lam, P., Foong, Y.Y., "Assessment of math structure of learning outcome proficiency attainment levels using hierarchical items in testlets", Educational Research Quarterly, Vol.22, No.2, 1998, pp.3-11

Lawless, C., "Investigating the cognitive structure of students studying quantum theory in an open university history of science course: A pilot study", British Journal of Educational Technology, Vol.25, No.3, 1994, pp.198-216

Lederer, A.L., Prasad, J., "A casual model for software cost estimating error", IEEE Transactions On Software Engineering, Vol.24, No.2, February 1998, pp.137-147

Little, R.J.A., “Regression with missing X’s: A review”, Journal of the American Statistical Association, Vol.87, No.420, 1992, pp.1227-1237

Lu, M.T., Johnson, N., “A virtual B-school through information technology: Framework and case study”, Journal of Computer Information Systems, Spring 1998, pp.58-63

Mandinach, E.B., Cline, H.F., “Classroom dynamics: The impact of a technology-based curriculum innovation on teaching and learning”, Journal of Educational Computing Research, Vol.14, No.1, 1996, pp.83-102

Mann, B., “Enhancing educational software with audio: Assigning structural and functional attributes from the SSF model”, British Journal of Educational Technology, Vol.26, No.1, 1995, pp.16-29

Marold, K.A., “Microcomputer user interfaces and intrapersonal communication”, Interface, Vol.15, No.1, 1993, pp.33-40

Matthews, D., “Transforming higher education, Implications for state higher education finance policy”, Educom Review, Vol.33, No.5, September/October 1998, pp.48-57

McDonald, R.P., “Path analysis with composite variables”, Multivariate Behavioral Research, Vol.31, No.2, 1996, pp.239-270

McKavanagh, C., Kanes, C., Beven, F., Cunningham, A., Choy, S., A conversational framework for the evaluation of web-based flexible learning in VET, Unpublished working paper for the Centre for Learning and Work Research, Faculty of Education, Griffin University, Australia, approx. 1998

McKeague, C.A., Di Vesta, F.J., “Strategy orientations, learner activity, and learning outcomes: Implications for instructional support of learning”, Educational Technology, Research and Development, Vol.44, No.2, 1996, pp.29-42

Merrill, M.D., Li, Z., Jones, M.K., “ID2 and constructivist theory”, Educational Technology, Vol.30, No.12, 1990, pp.52-55

Milano, D.R., Arens, J.R., “Microcomputer test banks for accounting principles: An evaluation”, Issues in Accounting Education, Vol.2, No.1, 1987, pp.85-93

Mills, A.M., McQueen, R.J., “Developing user sophistication in the organisation: An empirical investigation”, Pacific Asia Conference on Information Systems, 1997

Moncada, S.M., “Applying cooperative learning to MIS education”, Interface, Vol.15, No.1, 1993, pp.11-15

Moore, T.E., “The corporate university: Transforming management education”, Accounting Horizons, Vol.11, No.1, March 1997, pp.77-85

Mowete, R.G., “Enhancing conceptual learning in a systems analysis course”, Interface, Vol.14, No.4, 1992, pp.2-6

Newby, T.J., Ertmer, P.A., Stepich, D.A., "Instructional analogies and the learning of concepts", Educational Technology, Research and Development, Vol.43, No.1, 1995, pp.5-18

Newsted, P.R., Munro, M.C., Huff, S.L., Data acquisition instruments in management information systems, Harvard Business School Research Paper, 1991, Publishing Division, Harvard Business School, Boston, MA

Oglesbee, T.W., Bitner, L.N., Wright, G.B., "Measurement of incremental benefits in computer enhanced instruction", Issues in Accounting Education, Vol.3, No.2, 1988, pp.365-377

Penfield, P., Larson, R., "2014: An education odyssey", OR/MS Today, October 1996, pp.50-52

Plowman, L., "Narrative, linearity and interactivity: Making sense of interactive media", British Journal of Educational Technology, Vol.27, No.2, 1996, pp.95-105

Rafaeli, S., Ravid, G., Online, web based learning environment for an information systems course: Access logs, linearity and performance, http://mis.huji.ac.il/papers/mmm.paper.htm

Richetti, C., Sheerin, J., "Helping students ask the right questions", Educational Leadership, November 1999, pp.58-62

Roberts, E.S., In defence of the survey method: An illustration from a study of userr information satisfaction, Unpublished working paper for the Department of Accounting and Finance, University of Melbourne, Australia, approx. 1998

Ryser, G.R., Beeler, J.E., McKenzie, C.M., "Effects of a computer-supported intentional learning environment (CSILE) on students self-concept, self-regulatory behavior, and critical thinking ability", Journal of Educational Computing Research, Vol.13, No.4, 1995, pp.375-385

Segars, A.H., Grover, V., Teng, J.T.C., "Strategic information systems planning: Planning system dimensions, internal coalignment, and implications for planning effectiveness", Decision Sciences, Vol.29, No.2, 1998, pp.303-345

Shin, E.C., Schallert, D.L., Savenye, W.C., "Effects of learner control, advisement, and prior knowledge on young students' learning in a hypertext environment", Educational Technology, Research and Development, Vol.42, No.1, 1994, pp. 33-46

Tennyson, R.D., "The big wrench vs. integrated approaches: The great media debate", Educational Technology, Research and Development, Vol.42, No.3, 1994, pp. 15-28

Verma, M., Chhatwal, J., Singh, T., "Reliability of essay type questions – Effect of structuring", Assessment in Education, Vol.4, No.2, 1997, pp.265-270

Wagner, Z.M., "Using student journals for course evaluation", Assessment & Evaluation in Higher Education, Vol.24, No.3, 1999, pp.261-272

Waller, N.G., "Software review, Seven confirmatory factor analysis programs: EQS, EzPATH, LINCS, LISCOMP, LISREL 7, SIMPLIS, and CALIS", Applied Psychological Measurement, Vol.17, No.1, March 1993, pp. 73-100

Wang, R., Sedransk, J., Jinn, J.H., "Secondary data analysis when there are missing observations", Journal of the American Statistical Association, Vol.87, No.420, 1992, pp.952-961

Warschauer, M., Motivational aspects of using computers for writing and communication, Second Language Teaching &Curriculum Center, 1996

Whalley, P., "Imagining with multimedia", British Journal of Educational Technology, Vol.26, No.3, 1995, pp.190-204

Yildiz, R., Atkins, M., "The cognitive effect of multimedia simulations on 14 year old students", British Journal of Educational Technology, Vol.27, No.2, 1996, pp.106-115

Young, J.D., "The effect of self-regulated learning strategies on performance in

Appendices

Appendix A: Case Study Protocol Details

Case study framework

This section includes:

- The Case Study Framework with: the Time frame of the case study, the Units of Analysis and the Criteria for interpreting the study's findings
- Overview description of research processes to be carried out
- Field procedures to be carried out
- Case study questions

Time frame of case study

This study will be done in the context of a larger, full year, introductory accounting course involving over 600 students. The course will take place from early March 1998 to early October 1998. Total number of lecturing weeks will be 25 weeks, broken into 4 terms of approximately 6 weeks. The course consists of two hours of lectures per week, conducted in two large streams of more that 300, plus one hour of tutorials per week. Formal summative assessment will consist of a term test (30%), a practical computerised accounting test in a computer lab (5%), a written project (10%) and a final exam (55%). The portion of the course that will be the focus of this study will be the double entry accounting portion, which will occur early in the course from mid-March to early April. The time frame for the conduct of the case study can be seen in Figure 3-6.

Dates	Description
6-13 March 1998	Test courseware and treatment group survey instrument on group of first year volunteers not taking AFIS 111 (from AFIS 123)
10 March 1998	Conduct pre-test during lecture times
11 March 1998	Train tutors in use of AFIS On-line system
16 March-3 April 1998	Conduct tutorials, observations and interviews
30 March-3 April 1998	Conduct learning survey during last tutorial of series
7 April 1998	Conduct post-test in lecture times
3 April 1998	Conduct focus group meetings

Figure 3-6: Time frame of case study and data collection

Units of analysis of case study

This study includes both the primary unit of analysis, an accounting class and three embedded units of analysis: individual tutorial groups, individual students and groups of tutorials (treatment group and control group). The focus of the study is effective learning, in this case the effective learning of double entry accounting, and thus naturally includes the individual students as well as the larger units: the tutorials and the full class. Given the experimental portion of the study the tutorials are divided into treatment and control group tutorials.

Criteria for interpreting the study's findings

The fundamental criteria for interpreting the study's findings will be the extent to which the findings support or contradict the research question, hypothesis and theoretical model established at the beginning of this chapter. This theory driven approach will attempt to use the multiple sources of evidence to triangulate the results, strengthening the assertions made and recommendations for future work, in the light of the formative analysis.

Description of research processes to be carried

The chosen multiple method research approach involves a number of processes to be carried out to achieve the research goals. In addition to creating appropriate course content it will be necessary to have the entire process reviewed and approved by the University of Canterbury Human Ethics Committee, which oversees all research involving human subjects.

Processes required before conducting the research include appropriate liaison with the course supervisor and lecturers in the target first year accounting course. This liaison will cover issues of content and logistics in this large course with over 600 students (with two streams, a morning lecture group and an afternoon lecture group). In addition the creation and validation of the necessary test and survey instruments will be needed (covered in the following section).

Field procedures

The procedures to be carried out in implementing the research design and gathering data can be organised in line with the types of field work to be carried out. These include:

1. Tutorial observations
2. Individual student interviews
3. Tutor email messages from students
4. Focus group meetings
5. Experiment
6. Survey

This section will conform to this outline, including the various procedures carried out for each of the types of field work.

Tutorial Observation procedures

1. Two tutorials will be selected for observation from among the 15 tutorials that will be randomly selected for inclusion in the treatment group.

2. Weekly observations of these two tutorials will be conducted during the three weeks over which the tutorials run.

3. The researcher will enter the tutorial at the beginning of the session and take a position at the rear of the computer lab, the position from which the observations will take place. The researcher will maintain a passive role, leaving the tutors to conduct the session in their normal fashion.

4. Observations of the treatment group will be conducted to see their reaction to the treatment, the purpose being to discover why the treatment worked (or didn't work) and to verify the administration of the treatment. The same two tutorials will be observed each week.

Interview procedures

1. A group of individual students from each of the two tutorials to be observed will be identified as potential interviewees. They will be selected from the tutorial class list with the intention of yielding a group of interviewees that represent a balance of backgrounds. Selection will be made on the basis of demographic information provided on the pre-test (taken prior to beginning the tutorial series). The criteria used will be: gender, ethnicity, age, prior accounting background and prior computing background.

2. Toward the end of the first observation session the researcher will approach three individual students from each tutorial to request their participation in one-on-one interviews. If a student declines to participate the first backup will be approached, and so on until three students from each of the two tutorials being observed agree to participate in the series of interviews.

3. Each interviewee will be asked to attend a weekly 20-30 minute interview on the day or two following the actual tutorial. A specific appointment time will be negotiated with the student. The student will be told the reason for the interviews will be to gain insights from their personal experience of the web enabled course material and to discover what they believe is working well or poorly.

4. At the interviews the interviewee will be asked if they will permit the session to be audio taped, and then they will be asked a series of largely open questions.

5. The next appointment time will be negotiated with each student at the end of each interview.

6. Interview one will consist of a set of screening questions and questions about student's initial impressions on the AFIS On-line learning system. (See Appendix E and E-1)

7. Interview two will focus on issues related to the three primary environmental variables: control, feedback and in-context learning. At the close of this interview students will be asked to complete a journal over the next week to capture any key factors, questions and experiences with the AFIS On-line learning system.

8. Interview three will review student's journal comments and questions and provide an opportunity to clarify student responses on the learning survey completed in the final tutorial of the series.

Focus group procedures

Focus group meetings will be conducted with the treatment group to learn their perceptions of the on-line learning process, and to discover their attitudes and insights to further enrich the depth of the research.

1. There will be a total of 15 tutorial groups in the Treatment group. Two tutorials will be observed and a selection of students interviewed as noted above. Additionally 30 students will be selected from the remaining 13 treatment tutorial groups to participate in two focus group meetings.

2. Two to three individual students from each of the thirteen tutorials will be identified as potential participants. They will be selected from the tutorial class list with the intention of yielding a group of interviewees that represent a balance of backgrounds. Selection will be made on the basis of demographic information provided on the pre-test (taken prior to beginning the tutorial series). The criteria used will be: gender, ethnicity, age, prior accounting background and prior computing background.

3. The students will be invited to participate in a short (30-40 minute) group discussion on the learning that has taken place in the AFIS On-line tutorials.

4. Upon accepting the invitation the students will be assigned to one of the two focus groups in such a way as to maintain the balance of gender, ethnicity, age, prior accounting background and prior computing background.

5. Each of the two focus groups will meet with a facilitator. One group will be facilitated by the researcher, the second group by a facilitator from the University's Educational Research and Advisory Unit.

6. The facilitator will then carry out the following group process:

7. Brainstorm the best/most useful factors/features of the AFIS On-line learning system, writing on whiteboard. After brainstorming is complete discuss items with students to verify their understanding and to consolidate similar items. An associate will quietly capture the same items into a computerised list that students will then use for multi-voting and categorisation. This is to avoid the internal validity issue of student peer pressure affecting individual student voting patterns.

8. Brainstorm the worst/most confusing, most needing improvement features of the AFIS On-line learning system, writing on whiteboard. After brainstorming is complete discuss items with students to verify their understanding and to consolidate similar items. An associate will quietly capture the same items onto a computer connected to the departmental LAN. This computerised list will then be used by students for multi-voting and categorisation.

9. The lists of brainstormed items will then be printed out via the departmental LAN, and a secretary will photocopy sufficient copies for students to use in the multi-voting process, bringing them to the room where the focus group meeting is being held. A sample of this document (without any items) may be seen in Appendix F.

10. Carry out a multi-voting process on each list to rank order them, students will be given a printed copy of the list to vote on. Students will be instructed to vote for their top Most

Important (or Worst, Most Confusing, Most Needing Improvement) items. See instructions on Appendix F.

11. Categorisation: carry out a categorisation process to determine which items are related to each other by first discussing the categories: F (feedback), C (control), I (in-context learning) or O (other) so students are clear on what they mean. Then, students will use the same sheets as for item (3) above (see sample attached).

Tutor email procedures

1. Students will be encouraged to use email in communicating with their tutors.

2. This email will be captured in an archive and analysed to enrich the qualitative data of this research.

3. The archive of email will be analysed and categorised for common themes.

Follow up interview with best and worst performers

1. A review of best and worst performers on the pre-test/post-test will be conducted by reviewing improvement scores. The best and worst improved students will be invited for interviews. A target of 3 students in the best and 3 in the worst categories.

2. Students agreeing to attend interview (30 minutes in length) will be asked a series of open questions aimed at discovering the internal and external issues that were affecting their performance at the time.

Experimental procedures

1. All students in the course will self select into 30 tutorial groups in the normal fashion.

2. The concept of the research will be described to all students in the two lecture streams, a handout sheet describing the process and asking for their participation will be distributed at the same time (this sheet and the process having been approved by the University's Human Ethics Committee). Students will be asked to complete the authorisation and return it to the researcher. This document may be seen in Appendix B.

3. The researcher will then randomly choose 15 of these tutorials to be the treatment group with the remaining 15 tutorials to be the control group, using the Eton Statistical and Math Tables, 4th edition, 1980 random number tables. Student movement will only be permitted between like tutorials (treatment or control group tutorials) during the treatment period.

4. Tutors will be assigned to tutorial groups such that any given tutor is tutoring some tutorials in both the treatment and control groups.

5. A pre-test will be given to all students in the course (including both treatment and control groups) covering their accounting knowledge and attitude towards accounting and computing prior to the three week treatment. Two versions of the pre-test will be created. One will be used with the morning lecture stream and the other with the afternoon lecture stream. A sample of the pre-test may be seen in Appendix I-1. A further discussion on the

construction and validation of this instrument is included in a following section of this chapter entitled Design of Experimental Component.

6. The treatment group will attend World Wide Web based accounting tutorials for three weeks, while the control group attend traditional face-to-face discussion tutorials.

7. Both groups will continue attending traditional lectures as one larger group (in two lecture streams).

8. A post-test will be given after the three week treatment period, reversing the order of the test versions given to the morning and afternoon lecture groups during the pre-test.

<u>Survey procedures</u>

1. Surveys will be administered to each tutorial within the treatment group and the control group during the final (third) tutorial of the treatment period, the purpose being to discovery student opinions on various aspects of the learning process and environment.

2. The survey for each group (treatment and control) will incorporate items dealing with the three primary environmental variables being measured: control, feedback and in-context as well as items to discover time-on-task and an open question. Given the different nature of the two learning environments, many of the questions will be different between the two surveys. However common questions on each of the three main environmental variables will be included. Copies of the two surveys can be seen in Appendices D and D-1. A further discussion on the construction and validation of this instrument is included in a following section of this chapter entitled Design of Survey Component.

3. During the third tutorial (final one of the treatment period) of the series, tutors will distribute the survey to all students present in the tutorial. Students will complete the survey during the last portion of the tutorial period and return to the tutor before leaving the room. A copy of the tutor instructions may be seen in Appendix J.

4. Students who are not present in the tutorial room will be given an opportunity to collect a survey and complete in the few days following the last tutorial. This will be announced in lecture.

Case study questions

<u>Tutorial Observation questions</u>

- What are the type and frequency of questions asked by students of tutors?
- What are the type and frequency of questions asked by students of peers?
- Are the activities as designed for the web enabled course work actually carried out?
- Are there any extraneous activities carried out or instructions given by tutors?

Interview questions

- See Appendix E for interview questions and related material

Focus group questions

1. Students will be asked to state what they experienced as the best/most useful factors/features of the AFIS On-line learning system.
2. Students will be asked to state what they experienced as the worst/most confusing, most needing improvement features of the AFIS On-line learning system.
3. Students will be asked to vote for their top Most Important (or Worst, Most Confusing, Most Needing Improvement) items. See instructions on Appendix F.
4. Students will be asked to categorise which items are related to each other by first discussing the categories: F (feedback), C (control), I (in-context learning) or O (other) so students are clear on what they mean. Then, students will use the same sheets as for item (3) above. See Appendix F for a sample.

Tutor email questions

There will be no specific or guiding questions as the purpose of this data gathering process is to discover other issues raised by students of an unknown or unexpected nature.

Follow up interview with best and worst performers: questions

See Appendix H for a copy of the questions that were asked.

Experimental questions

See Appendix I-1 for a copy of the pre-test which specifies the questions asked.

Survey questions

See Appendices D and D-1 for a copy of the treatment and control group surveys which specify the questions asked.

Appendix B: Ethics Committee Information Sheet

University of Canterbury

Department of Accountancy, Finance and Information Systems

You are invited to participate as a subject in the research project: Using the World Wide Web (WWW) for more Effective Higher Education.

The aim of this project is to discover if the use of World Wide Web enabled learning applications are more effective for student learning than traditional face-to-face meetings.

Your involvement in this project will involve attending the regularly scheduled AFIS 111 tutorials during weeks 3, 4 and 5. Some students will attend face-to-face tutorials while others will attend WWW enabled tutorials, the choice of which will be carried out by the researcher on a random basis. Some of these sessions will be observed by the researcher in a passive fashion. In conjunction with this you will be asked to complete a pre-test during normal lecture time, and a survey during tutorial time. The time required should be no more than you would usually spend in a typical tutorial, depending always on your desire to learn and enthusiasm for the subject. In addition some students may be asked to participate in an interview or a small group discussion on your impressions of the learning experience. As a follow-up to this investigation, you will be asked to complete a post-test, again during normal lecture time.

For those who participate, you will receive feedback on your performance in the pre-test and post-test showing the improvement in your understanding of basic accounting processes. Those who attend the face-to-face tutorials will be given the opportunity to make use of the WWW tutorial material following week 5.

The summary results of the project may be published at a later date, but you may be assured of the complete confidentiality of data gathered in this investigation: the identity of participants will not be made public without their consent. To ensure anonymity and confidentiality the pre-test, post-test and survey papers will be processed under the direct supervision of the researcher, kept under lock-and-key controlled by the researcher, and all documents will be destroyed on completion of the research. Feedback to students on their personal performance will be in the form of a list showing only the student ID number for identification.

If at any time you wish to withdraw your participation you are permitted to do so.

The project is being carried out by John Vargo, who can be contacted at 364-2627. He will be pleased to discuss any concerns you may have about participation in the project.

The project has been reviewed by the University of Canterbury Human Ethics Committee.

Consent and Enrolment Form: World Wide Web (WWW) for more Effective Higher Education Project

I have read and understood the description of the above the named project. On this basis I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided.

Signed.. Date.......................................

Student ID Number...

If I am in a WWW tutorial group I would like my scenario to be (circle your choice):

CD Music Shop	Gourmet Deli	Clothing Shop

Appendix C: Comments from observations and interviews

Comments from observations

Week	Tutorial	Comments
1	1	After researcher arrived, students seemed quite happy to ignore his presence and get on with the tutorial. Tutor made a few short announcements including the experimental nature of this tutorial material and that she had posted a message to the on-line bulletin board. She then asked students to pair off, meet one another and then a few minutes later to introduce one another. After this she went quietly around the room taking roll in a one-on-one mode. The tutor also gave students the tutorial handout for the day and their TopClass User ID and Password at this point. Some students had trouble logging in to Windows NT while others got straight on to NT, read the tutorial handout, ran Netscape, and logged into TopClass with no problems. Those who had difficulties logging in to NT were due to their not having brought their Campus network User ID and Password. This was inspite of the fact that an introductory tutorial had been run the previous week for learning about NT, logging in, using the Pegasus email system, basic Web browsing and creating, saving and printing files with MS-Word and PowerPoint. Some did have their enrollment receipt, which has the ID and password on it, others were sent off to get it from the dorm or from CSC. This affected 2-3 students out of a class of 19. The tutor encouraged students to read the handout and explore the course-work and read on-line messages to familiarise themselves with the system. She then asked all students to send a message to one another using the TopClass mail system. After all students were logged in (16 students were present and logged in at one time) the researcher measured TopClass system response times, finding that the system responded in 2-3 seconds for all requests, including test marking. Taking 8-10 seconds to load Excel for the spreadsheets. (It was reported to the researcher by a student in another tutorial that he had experienced a longer delay on the test, 10+ seconds, but this was not verified, nor the circumstances verifiable.) Once all were logged in and working, there was very little discussion between students, except in one or two cases where a student did not have their ID and password, and thus had paired up with a friend to do the tutorial for today. Occasionally a student would put their hand up to get assistance from the tutor, most frequently due to being confused on what was expected next. This confusion usually came as a result of not reading the instructions closely on the tutorial handout. The most common questions, apart from early navigation questions, were in regards to the Excel spreadsheets. Many students were using the scroll bar to move up and down between the instructions and action parts of

		the spreadsheet, not having read the instructions to use Ctrl-F6 to toggle from one to the other. Some students spent the majority of the session just exploring the system and learning navigation. The tutor was very good, moving around and asking questions and directing those having trouble. During the tutorial, the researcher asked the tutor for the roll sheet, and verified that those students who had been selected for interviewing were present in class. Three out of four were present. At the end of the tutorial, the researcher spoke privately with each of these students, asking if they would be willing to participate in interviews, and inviting them to the first interview the next day, negotiating a suitable time.
	2	After researcher arrived, students seemed quite happy to ignore his presence and get on with the tutorial. Tutor made a few short announcements, including the fact that she would come around with TopClass user IDs and passwords. Students just sat and waited, or read the tutorial handout (which tutor had given out as students arrived in lab) or ran Netscape and tried to login to TopClass. Tutor them moved about the class taking on-on-one roll and giving out TopClass IDs and passwords. Similar problems as with the first tutorial observed, in terms of difficulties in logging into NT, due to not having campus Ids and passwords with them. This affected 2-3 students out of the class of 17. Most students worked away quietly once logged in, learning navigation in TopClass and generally familiarising themselves with the system. Some got stuck on the spreadsheet, and didn't get to the tests and feedback during this tutorial time. Again, tutor moved quietly about the room responding to students hands-up, directing and asking questions and answering questions. Many seemed to have little familiarity with Excel and found the Excel exercise a bit confusing, since this was the prime source of questions after the initial logging in and navigation questions. One student got the spreadsheet finished, and it balanced. But it did not match the answer spreadsheet provided, and there was not sufficient feedback on the answer spreadsheet so the student would know where they went wrong. Again during the tutorial the researcher asked tutor for the roll sheet to determine if the students selected for the individual interviews were present. All students were present, and at the end of the tutorial were approached to determine their willingness to participate in the interviews. All agreed to participate, and a suitable time was negotiated for the next day. However one of the students, an Indian woman in her 30s, never showed for the interview. Her English was particularly poor, when approached initially, and it is possible that she agreed, but did not understand. This student was not persued for the interviews and the researcher proceeded with five student interviewees.

2	1	Students were given today's tutorial handout as they entered the class, went to a computer and immediately logged in and proceeded to do the tutorial, raising a hand when they needed help, which was much more infrequent that the previous week. One student was still having trouble logging into NT, not having sorted their ID and password out from the previous week. There appeared to be very little usage of the email and bulletin board system, with most students putting up their hand to ask a question, rather than using the electronic communication. This is no surprise given the in-lab nature of the course. Some students were still noted as using the Excel scroll bar, rather than Ctrl-F6, with some showing a bit of frustration over the navigation in Excel, similar to the previous week, but much less frequent occurrence. The use of Ctrl-F6 solution to this particular issue in Excel had been posted to the Discussion list the previous week as well as being included in the this week's tutorial handout. A few students still had not sorted it out however. It was noted that there was a reasonable amount of students-helping-students happening spontaneously, with 3 pairs of students noted (6 students) out of the class of 16 present. A few students showed considerable frustration with tutor, who spent quite a bit of time with a student with poor English skills, who couldn't quite understand that her enrollement receipt had her User ID and password on it. A few students asked tutor if the TopClass tests were going to count toward their final grade (the answer was no.). It was quite apparent that the navigation in TopClass was not a problem, with students getting on with it without any difficulties, after the first tutorial. Students all seemed to be using the learning aids (on-line dictionary, hints, tests , spreadsheet without any difficulty) Some students asked if they needed to do all three tests in each episode? The tutor answered appropriately, "only if you are not doing well". FAQ feature not being used much, since most questions are being handled in a face-to-face situation.
	2	While walking to tutorial with the tutor, she commented to me the some students really loved it, completing the tutorial work from home/flat. She also said one student (male) had really been very negative in the first tutorial, but was now very enthusiastic. Tutor handed out today's tutorial sheet as students arrived, and students went straight to logging in and doing the tutorial work. When I tried to login I received the "Full up" error message, meaning that more than 25 were logged in at one time, even though this tutorial only had 16 logged in at the same time. Obviously students were logged in from other labs or from home. I immediately had Jenni make the rounds of the other Vault

		tutorial rooms and ask students to log off. I also accelerated our earlier request to have our license upgraded to 50 users. This took until early the following week to accomplish due to various issues (first they sent us a key for TopClass 2.0, but we did not want to install the upgrade (we were using version 1.3b) until after this experiment was completed.) Most students were working away quietly, with one or two "collaborative" discussions occurring, part work and part social in nature! One of the questions that came up twice was on an error in the answers for one question on one of the tests. (Q1, T2, Episode 1) It was further noted that there appeared to be almost no useage of the Discussion List. Later discussion with tutors showed that some students were using the system, but when they sent a message it was going to the tutor directly and not showing up on the discussion list. In many cases email from multiple tutorials were going to only a single tutor, whereas that email should have been going to the tutor of the tutorial session. TopClass systems people were a bit mystified by this and are working on a fix. Tutors were substquently notified to send all non-confidential email concerning the TopClass tutorials to me, Jenni co-ordinated this.
3	1	Tutor handed out this week's handout, instructing students to carry on with episodes 3 &4 and that if they don't finish them today, they will still have access to them over the next few weeks. Tutor also announced the need to post a couple of messages to the discussion list (per today's handout). Students then simply got on with doing the tutorial. They seemed to have gotten the handle on the Ctrl-F6 in Excel. No apparent technical problems. As students put their hands up tutor made the rounds to help out as needed. It was noted, in reviewing the roll sheet that a fair number of students had moved tutorial groups. A procedure was put in place in conjunction with George Thompson (AFIS 111 course supervisor) and the departmental secretaries so that students wishing to change tutorials could do so, but they were constrained to only move to a similar (computer based, or face-to-face discussion) tutorial type.
	2	Tutor handed out today's tutorials sheets as students arrived and students simply got on with the tutorial material, working quietly away. Tutor made the rounds as usual, responding to hands up for help. Afterward the tutor related to me that one of the other tutors had gotten an anonymous email that simply read "I like you!" Tutor also commented on lack of use of FAQ by students due to face-to-face nature of the labs with tutors responding to queries as the hands go up. Also the moderator, was not

		receiving and distilling the email coming in to the tutors and then posting as FAQs!

Comments from interviews

Week	Student	Comments
1	Intro	The purpose of the first week interviews was to verify interviewees suitability and gain their initial impressions of the AFIS On-line concept and their experience of it initially. Questions included: what is your major; give me your impressions of the AFIS On-line concept; what did you find most interesting; what did you find most difficult or confusing; what other impressions did you have; what is your overall comment so far.
1	1	This student's major is a Bcom in computer science. His initial impressions were that it looked pretty good, but he only got to the first spreadsheet and not to the tests. He particularly liked the anywhere, anytime flexibility of the concept. He found the spreadsheets very good, but still needed to use paper for calculations to maintain balances in the accounts. His overall comment was that he needed to spend more time with it before he could give a proper impression.
1	2	This student is an Information Systems major. He particularly liked the ability to do it from home on the Internet (or from wherever). He also liked the immediate feedback on the tests. He did find the initial login screen a bit confusing, not sure what is happening, or what to do, also found the email system a bit confusing on both navigation and how to delete a single message. His overall impressions are that this is a very useful approach and a good way to learn. Later in the week this student sent the researcher an email. The substance of that email was that a major advantage of the computer tutorials is the self paced nature of it, with students of all accounting and English abilities being able to spend as much time as necessary to learn the material.
1	3	This student intends to be an accounting major, but has only a little background in accounting and none in computing. Her initial impressions are that she likes the system especially the automatic marking and rapid feedback on the tests. She said that because English was not her first language and she was new to computers everything was a bit confusing at first. She felt that she needed more time with the system before she could give a proper impression.
1	4	This student has not decided her major yet. Her initial

		impressions were that the system was easy to use and learn from, she already is competent in accounting and has some experience with computers. She found the navigation most interesting and easy, and found waiting for the tutor (if you got stuck) the most frustrating. She felt the tutor preparation could be better for the computer side of things.
1	5	This student's major is accounting. His initial impressions are that this is better than discussion tutorials, especially for those with some experience in accounting, it is more flexible, and they can do it when they want. He particularly liked the spreadsheet exercises and the immediate feedback on the tests. He did feel however that the Hints don't give the answers and should be more helpful. Over all impression is that it is very good and likes it.
2	Intro	The purpose of the interviews in the second week was to gain an update on the student perceptions of the AFIS On-line system and begin gaining insight into the key variables of feedback, in-context learning and control, by using questions related to the survey questions. I also asked if the students/interviewees would be willing to maintain a written record/diary during the final week to make the last interview easier. All students were willing to do this.
2	1	His comments on FEEDBACK issues were that he liked the tests and rapid feedback from them, but did not have time to get onto the discussion lists and email usage. He felt that the IN-CONTEXT learning items such as the hints, scenario, test questions and spreadsheet hang together well, but he felt that it depended on the level of accounting background as to whether it would all be enough information, especially for the total beginner. Regarding CONTROL, he particularly liked the flexibility of the time and place independence. He had no complaints at the moment except that he felt that more instructions were needed, especially on the spreadsheets and editing cell values so that students don't have to use paper and pencil to maintain account balance (he had discovered since last week that by editing cell values the spreadsheet would add up any new transactions added to a particular balance). He had not overheard any comments from other students.
2	2	Regarding FEEDBACK this student thinks information should be given on WHY the right answer is right (or wrong) and that other types of questions should be used (not just multi-choice, eg fill-in etc.). On the IN-CONTEXT- learning aspect he thought the hints and dictionary were very helpful (usually) for more experienced people, but sometimes a bit inconsistent in usefulness and quality. Regarding CONTROL he really liked the control over pace and the flexibility of the 24 hour anytime and anywhere access. See

		his comments from email of week one included in notes for week one interview above for more.
2	3	Regarding FEEDBACK this student emailed tutor with a problem in the textbook, she also found the answers to the on-line tests very useful for learning. On the IN-CONTEXT learning she found that for some test questions the hints work really well, while for other questions there is not enough information. She found the second episode harder that the first one. She liked having CONTROL over her environment, but could not explain in detail, had not used after hours or off campus. She likes the idea of the discussion list and has read the postings, but did not post anything herself. Primary recommendation is better hints on some questions.
2	4	Regarding FEEDBACK this student thought it was often easier to just ask the tutor. She also thought that if you got a question wrong that you needed more feedback than was available on the test feedback screen (eg access to the hint button and resources at this point of feedback!!). She felt that the IN-CONTEXT issue with the scenarios, spreadsheets etc all tied in quite good and liked it, but did have some difficulty on the level of feedback on the spreadsheets if you had it wrong. On the issue of CONTROL, thought it was great to be able to login from the Library (loft). She also thought the dictionary was very good and pitched about right, and also liked the suggested times at beginning of scenario and thought it was pretty accurate. A point of complaint was the inability to discuss issues (eg ethical issues) that could be done in a discussion tutorial. She thought mixing the two (computer with discussion) could give you the best of both worlds.
2	5	Regarding FEEDBACK, the student felt that the comments on the answers to the tests (when you had a wrong answer) were not always helpful (they did not give you the right answer, but only a hint!). He found having the tutor in the room was good for giving explanations when you needed it. He felt that on the IN-CONTEXT learning that the spreadsheet tied in quite good to the scenario, but that the dictionary was sometimes hard to understand for international students, and that hints did not give enough help (didn't give the actual answer). He also liked the textbook references in the help. Regarding CONTROL he liked the 24 hour access from anywhere aspect. Other things he liked included the flexibility or 24 hour anywhere access, self pacing on time, quick feedback and the side benefits of becoming more familiar with computer usage. For improvements he felt that at times the navigation was a bit confusing especially in discussion list, could use access to email at bottom of test feedback answer sheet, and that some questions were left with too many assumptions (eg accounting entity not clear with owner's private

		cash or business bank acct)
3	Intro	The third week's interviews were based on two things: (1) the diary the student had kept of their AFIS On-line experience during the last week and (2) The students responses on the survey that was used with all students.
3	1	Regarding feedback, the student really likes the on-line tests, in particular the explanation if you have the wrong answer, but some questions could have better explanations for wrong answers. Regarding the context of learning, the student found the tests and spreadsheets easy to follow and liked the hint button and examples for the harder questions. Regarding control, the student liked the ability to access from home and after hours, permitting ability to study at times suitable, even late at night. Particularly liked the 24 hour access, the interesting layout of the material and web site and the instant test results. However the student did report problems with reading some parts of the material because of the yellow check background on some pages, might need a bolder font. Also noted were a few spelling errors in some of the tests and spreadsheets. In reviewing student's responses on the Learning Survey, the student expressed indifference to the ability to choose episode type. The student confirmed that the episode scenarios, 24 hour access, on line dictionary and hint buttons were especially useful (score =6 on survey), while the practice spreadsheets were less useful. The student did not make any use of the email, FAQs, discussion groups or the on-line text book references. The student did find all of the other features used to be very helpful (score=5 on survey). This students did access the system from off campus and after hours.
3	2	
3	3	The student did access the system from outside of tutorial hours but not from off campus.
3	4	Regarding feedback, the student felt that more explanation was necessary when you get a question wrong. Regarding context of learning, the student felt that the questions on the different versions of the test were too similar and the questions should be mixed up more to make it harder. Regarding control, the student particularly liked the 24 hour access outside of tutorial times. The student also liked the layout and presentation of the on-line course material. The student also had a comment overheard from other students that the spreadsheet with episode #4 was a bit confusing with one of the entries and the tutor also did not know how to do it (the 4^{th} entry in particular).

		In reviewing the student's responses on the Learning Survey, the student particularly liked ability to choose the episode and the context of the episodes, 24 hour access, control via the browser, the spreadsheets, on-line dictionary, general control over the learning environment, use of clarifying examples, control over pace and use of hint buttons (score=6 on the Learning Survey). The student indicated no useage on email with tutors and students, FAQs, discussion groups and on-line text book references. The student responded with score=5 on the remaining survey questions. The student did access the system from outside of tutorial hours but not from off campus.
3	5	

Appendix D: Treatment group learning survey

AFIS On-line (AFIS 111) Learning Survey

In the spaces below, we would like to gain your perceptions of the computer based (WWW) tutorials you have just completed for AFIS 111. Please complete the form below and return to your tutor when you are finished. Thank you for your cooperation.

Name:	Student ID:	Tutorial Day and Time:

	AFIS On-line Learning Survey: For each item below circle the numbered response that best describes your opinion based on your experience in the AFIS On-line tutorials over the last three weeks. Where you did not use or deal with a particular item, tick the **No Useage** box provided for some questions: 1=Strongly disagree, 6=Strongly agree		
		Learning This aspect helped me learn better	**No Useage** I did not use/do this
1.	Ability to choose my "Episode" type (Food/CD/Clothes)	1 2 3 4 5 6	❑
2.	Getting rapid automated feedback on the tests	1 2 3 4 5 6	❑
3.	The AFIS On-line system provided a cohesive, consistent, in-context, learning system	1 2 3 4 5 6	
4.	The ability to have two-way (email) communication with tutors	1 2 3 4 5 6	❑
5.	The use of Episode scenarios to add context to learning	1 2 3 4 5 6	
6.	Flexibility of timing and accessibility to material (24 hour access to WWW materials)	1 2 3 4 5 6	❑
7.	Availability of the Frequently Asked Questions (FAQs) Help	1 2 3 4 5 6	❑
8.	Availability of on-line discussion groups	1 2 3 4 5 6	❑
9.	Control provided by WWW browser and hypertext environment	1 2 3 4 5 6	
10.	Use of excel practice spreadsheets	1 2 3 4 5 6	❑
11.	Overall level of feedback	1 2 3 4 5 6	
12.	Availability of the dictionary on-line	1 2 3 4 5 6	❑
13.	Control over my learning environment	1 2 3 4 5 6	
14.	Relating to other students in tutorial	1 2 3 4 5 6	❑
15.	Use of clarifying examples	1 2 3 4 5 6	❑
16.	The ability to have two-way (email) communication with students	1 2 3 4 5 6	❑
17.	Availability of text-book references on-line	1 2 3 4 5 6	❑
18.	Ability to control the pace of my learning (I could take as much or little time as I needed)	1 2 3 4 5 6	
19.	Use of the "hints" button on the tests	1 2 3 4 5 6	❑
20.	Approximately how many hours (to the half hour) did you spend on the AFIS On-line (WWW) tutorial material including: time in tutorial, time after tutorial completing material, time discussing material with other students or tutors, sending/recieving email and reading FAQ and bulletin boards?	____________	hours
21.	How many tutorials/episodes did you attend/do? Tutorials: ❑ 1 ❑ 2 ❑ 3 Episodes: ❑ 1 ❑ 2 ❑ 3 ❑ 4		
22.	Did you access the WWW tutorial material outside of tutorial hours?	Y/N	
23.	Did you access the WWW tutorial material from off campus?	Y/N	
24.	What other comments do you have about the WWW tutorials?		

Appendix D-1: Control group learning survey

AFIS 111 Learning Survey

In the spaces below, we would like to gain your perceptions of the discussion tutorials you have just completed for AFIS 111. Please complete the form below and return to your tutor when you are finished. Thank you for your cooperation.

Name:	Student ID:	Tutorial Day and Time:

	AFIS Learning Survey: For each item below circle the numbered response that best describes your opinion based on your experience in the AFIS discussion tutorials over the last three weeks: 1=Strongly disagree, 6=Strongly agree	
		Learning This aspect helped me learn better
1.	In tutorial discussion of questions and problems	**1 2 3 4 5 6**
2.	Overall level of feedback	**1 2 3 4 5 6**
3.	Tutor's use of clarifying examples	**1 2 3 4 5 6**
4.	Solutions to tutorial questions	**1 2 3 4 5 6**
5.	Tutorial materials and discussion provided a cohesive, consistent, in-context, learning system	**1 2 3 4 5 6**
6.	Tutor's answers in tutorial	**1 2 3 4 5 6**
7.	Control over my learning environment	**1 2 3 4 5 6**
8.	Doing the Preparation Problems	**1 2 3 4 5 6**
9.	Solutions to Preparation Problems	**1 2 3 4 5 6**
10	Relating to other students in tutorial	**1 2 3 4 5 6**
11	Ability to control the pace of my learning (I could take as much or little time as I needed)	**1 2 3 4 5 6**
12	Approximately how many hours (to the half hour) did you spend on the AFIS 111 discussion tutorials during the last three weeks including: time in tutorial, time before tutorials doing Preparation Problems, time after tutorial completing material, time discussing material with other students or tutors.	______________
13.	How many tutorials did you attend? Tutorials: ❑ 1 ❑ 2 ❑ 3	
14	What other comments do you have about the AFIS discussion tutorials conducted over the last three weeks?	

Appendix E: Interview guideline questions

Interview protocol and documents

AFIS 111 Case Study Protocol

Select six students from two tutorials (three from each) for an initial screening interview. Goal is four interviewees who will be interviewed each week for the three weeks of the experiment/case. The selected group of four should be split two strong ACCY, two strong Computing with a good spread of age, sex and ethnicity. Screening questions to cover their: (1) intended major, (2) attitude towards computers, (3) experience with accounting, (4) a couple of specific questions on the AFIS On-line system for their experience this first week. Interviews to be conducted on Friday afternoon 20 March 1998

Student Interview Form: Screening interview to get four long term interviewees:

Student Name	**Student ID**	**Tut. Group**	**IS strength & attitude**	**Accy strength & attitude**

AFIS 111 On-line - TopClass Interviews

Appendix E-1: Week one interview guideline questions

:

Subject Name:_______________________ Tutorial group: ____________________

Objective: To screen interviewees for suitability and gain their initial impressions of the AFIS On-line concept and their experience of it so far.

Screening Questions:

1. What is your major?

2. Please give me your impressions of the AFIS On-line concept:

3. What did you find most interesting or useful?

4. What did you find most difficult or confusing?

5. What other impressions did you have?

6. What is your overall comment so far?

Appendix E-2: Week two interview guideline questions

Student Name: ______________________________ Tutorial: ____________________________________

Objective: To gain an update on student perceptions of the AFIS On-line system and begin gaining insight into the key variables of feedback, in-context learning and control, by using questions related to the survey questions:

Reflections/comments on FEEDBACK (from tests, discussion list, email with tutors and students, etc.):

Reflections/comments on CONTEXT OF LEARNING (case scenarios with related test questions, hints, dictionary, examples, spreadsheet etc.):

Reflections/comments on CONTROL (over timing, place (computer lab or home), 24 hour access, pace (take as much time as you like, or as little), choice of scenario (food, CD or clothes)):

Complements and things you particularly liked:

Complaints and things you did not like:

Recommended Improvements:

Comments overheard from other students:

Other

1. Would you be willing to keep a record of your experience with the system over the next week? A journal in which you can write down issues that come to your attention. either while using the system or while discussing it with other students. Just write down your issues, complaints, complements, comments of your own or other students.

Appendix E-3: Student Interviewee Journal

AFIS 111 On-line Journal for: ______________________________

Reflections on the AFIS On-line Learning Experience

Could you please note below your reflections, thoughts, issues, complements, complaints in the space below and on the back of this page. You are not limited to the categories given, they are just to get you started. If you could include comments from other students that you have heard in conversation, it would also be much appreciated. Thank you.

Reflections/comments on FEEDBACK (from tests, discussion list, email with tutors and students, etc.):

Reflections/comments on CONTEXT OF LEARNING (case scenarios with related test questions, hints, dictionary, examples, spreadsheet etc.):

Reflections/comments on CONTROL (over timing, place (computer lab or home), 24 hour access, pace (take as much time as you like, or as little), choice of scenario (food, CD or clothes)):

Complements and things you particularly liked:

Complaints and things you did not like:

Recommended Improvements:

Comments overheard from other students:

Other

Please add additional comments for the above categories, or any other comments on the back of these sheets, or on additional sheets. Thanks for your help!

Appendix E-4: Week three interview guideline questions

Student Name:________________________ Tutorial:____________________________

Objective: To follow up on student's Journal and on written survey responses with more in-depth why questions on the survey, going through the survey to gain a deeper understanding of what is going on with them:

What was actually used was the students journal (see previous page), with interviewer taking notes directly on the journal sheets as clarifying questions were asked about the journal. In addition the students survey form was pulled from the tutorial group and the student/interviewee was asked clarifying questions about their responses on the survey as well. This final interview was longer being 30+ minutes, while week one and two interviews were shorter being approx. 15 minutes.

Appendix F: Focus Group Brainstorm list

Features or Factors that are the: Best, Most Useful

Most important: In the column below marked Most Important, enter your votes for the top, most important items on the list. Your facilitator will tell you the number of votes you get to use. Just place a tick (✓) in the Most Important column for your top ______ most important items.

Category of item: In the column below marked Category of Item, tick only one box for each item to indicate the category that you believe the item belongs in: F (feedback), C (control), I (in-context learning), or O (other). Your choice should be based on the discussion of the categories lead by your facilitator.

Most Important	Item Description	Category of Item
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O
		❑ F ❑ C ❑ I ❑ O

Appendix F-1: Spreadsheet details of Focus Group outcomes

Results of Focus Group Conducted by ERAU (Rod McKay & Jane Robertson) for AFIS 111 On-line, 3 April 1998

Positives	1		2		3		4		5		6		7		8		
	Flexible timing/work in		Flexible location/acces		Quick feedback on tes		Questions go back to l		On-line help/dictionary		Textbook references		Spreadsheets		Practical examples		ChkSum
	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	
Student 1		I		C		I		F	1	F	1	F		F	1	F	3
Student 2	1	C		C		F	1	F		I	1	I		F		I	3
Student 3		C	1	C	1	F		I		I		I	1	I		I	3
Student 4		C	1	C	1	F		I	1	I		I		C		I	3
Student 5		C		C	1	F	1	O		I		I	1	I		I	3
Student 6		C		C		F	1	I	1	I		I		I	1	I	3
Student 7	1	F		O	1	F		O	1	I		O		I		I	3
Student 8	1	C		C		F		O	1	I		I	1	I		I	3
																	0
Total	8		8		8		8		8		8		8		8		
Important/Total	3		2		4		3		5		2		3		2		
Important %	38%		25%		50%		38%		63%		25%		38%		25%		
Category count		8		8		8		8		8		8		8		8	
Cat: Feedback		13%		0%		88%		25%		13%		13%		25%		13%	
Cat: Control		75%		88%		0%		0%		0%		0%		13%		0%	
Cat: In-context		13%		0%		13%		38%		88%		75%		63%		88%	
Cat: Other		0%		13%		0%		38%		0%		13%		0%		0%	

Negatives	1		2		3		4		5		6		
	Sometimes difficult to r		Sreadsheets confusing		Unable to save answe		Can't start where you l		Order of progression u		Test questions repeated ("give aw		**ChkSum**
	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	
Student 1		C		C	1	F	1	C		C		I	2
Student 2	1	F		O		C		C		I	1	F	2
Student 3		C	1	F		C	1	C		I		F	2
Student 4		C	1	C		C		C	1	C		F	2
Student 5		C		C	1	C		C		C	1	I	2
Student 6		C		I		C	1	C	1	I		I	2
Student 7		C	1	C		C		C		C	1	I	2
Total	12		12		12		12		12		12		
Important/Total	1		3		2		3		2		3		
Important %	8%		25%		17%		25%		17%		25%		
Category count		7		7		7		7		7		7	
Cat: Feedback		14%		14%		14%		0%		0%		43%	
Cat: Control		86%		57%		86%		100%		57%		0%	
Cat: In-context		0%		14%		0%		0%		43%		57%	
Cat: Other		0%		14%		0%		0%		0%		0%	

Results of Focus Group Conducted by John Vargo for AFIS 111 On-line, 3 April 1998

Positives	1		2		3		4		5		6		7		8		9		10		11		
	Quick test results		All the information req		Excel spreadsheets		Scenario-scene settin		Hint/help button		Flexible timing/24 hou		Flexible location (hom		Texbook reference pa		Not a lot of paperwork		Tests similar but suffic		Dictionary		ChkSum
	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	
Student 1	1	F	1	F	1	I	1	I		F		C		C		O		O		I		F	4
Student 2	1	F		F		F		F	1	I	1	C		I	1	I		I		I		F	4
Student 3		F		I	1	I		I	1	F	1	C		C		I		C	1	I		F	4
Student 4	1	I		I	1	I		I		I		I		I	1	I		O	1	I		I	4
Student 5	1	F		I		I	1	I	1	F		C		C		I		O		I	1	F	4
Student 6	1	F		I	1	C		F		F	1	C	1	C		I		C		O		F	4
Student 7	1	F		I	1	F		O		I		O		O		I	1	C		I	1	I	4
Student 8	1	F		C		I	1	O		F	1	C		C		I		O		I	1	I	4
Student 9	1	I		I		F		F	1	I	1	C		C		I		O	1	I		I	4
Student 10	1	F		F	1	I		I	1	F	1	C		C		I		O		O		I	4
Student 11	1	F		F	1	I	1	I		F	1	C		C		I		O		O		I	4
Student 12	1	F	1	I		I		O		I	1	C		C	1	I		O		I		I	4
Total	12		12		12		12		12		12		12		12		12		12		12		
Important/Total	11		2		7		4		5		8		1		3		1		3		3		
Important %	92%		17%		58%		33%		42%		67%		8%		25%		8%		25%		25%		
Category count		12		12		12		12		12		12		12		12		12		12		12	
Cat: Feedback		83%		33%		25%		25%		58%		0%		0%		0%		0%		0%		42%	
Cat: Control		0%		8%		8%		0%		0%		83%		75%		0%		25%		0%		0%	
Cat: In-context		17%		58%		67%		50%		42%		8%		17%		92%		8%		75%		58%	
Cat: Other		0%		0%		0%		25%		0%		8%		8%		8%		67%		25%		0%	

Negatives	1		2		3		4		5		6		7		8		9		10		11		12		
	Navigation in messag		Wrong answer,not en		Introduction to whole		U and N etc. no expla		Seemed to be testing		Too high level if never		Not enough explanati		Access to dictionary,		Some test questions		Spreadsheet #4 has		Some errors in tests		A pointer on to next section or in		ChkSum
	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	Important	Category	
Student 1		O	1	F		I		F		O		I	1	F		F	1	I		I	1	I		C	4
Student 2		C	1	F		F		F		I		O	1	F		F		F		F	1	F	1	C	4
Student 3		F	1	F		I		I		I	1	C		F	1	C	1	I		I		I		I	4
Student 4	1	O	1	I		I		I		C		I		F		C		I		F	1	O	1	C	4
Student 5	1	F	1	I		O		F	1	F		O	1	I		F		O		F		F		F	4
Student 6	1	F		F	1	I		I		I		I	1	F		I		F		I		I	1	F	4
Student 7		F	1	F		O		F		O		C	1	F		F	1	O		O		O	1	I	4
Student 8	1	F	1	F		I		I		I		I	1	F		F		I		F	1	F		F	4
Student 9		I	1	F	1	F		I	1	C		I	1	F		I		I		I		I		F	4
Student 10		C		F	1	I		I	1	I		I	1	F		I		I		I	1	I		C	4
Student 11		C	1	I		C		C		O		I	1	F	1	F	1	I		I		I		C	4
Student 12		F	1	F		I		O		O	1	I		C	1	I		C		O		O	1	F	4
Total	12		12		12		12		12		12		12		12		12		12		12		12		
Important/Total	4		10		3		0		3		2		9		3		4		0		5		5		
Important %	33%		83%		25%		0%		25%		17%		75%		25%		33%		0%		42%		42%		
Category count		12		12		12		12		12		12		12		12		12		12		12		12	
Cat: Feedback		50%		75%		17%		33%		8%		0%		83%		50%		17%		33%		25%		42%	
Cat: Control		25%		0%		8%		8%		17%		17%		8%		17%		8%		0%		0%		42%	
Cat: In-context		8%		25%		58%		50%		42%		67%		8%		33%		58%		50%		50%		17%	
Cat: Other		17%		0%		17%		8%		33%		17%		0%		0%		17%		17%		25%		0%	

Group 1 (Vargo facilitator) Summary of Results

Positives	Important	Category
Quick test results	92%	F=83, I=17
All the information required was availal	17%	F=33, I=58
Excel spreadsheets	58%	F=25, I=67
Scenario-scene setting	33%	F=25, I=50, O=25
Hint/help button	42%	F=58, I=42
Flexible timing/24 hour available	67%	C=83,
Flexible location (home/loft etc.)	8%	C=75, I=17
Texbook reference pages	25%	I=92
Not a lot of paperwork	8%	C=25, O=67
Tests similar but sufficiently different	25%	I=75, O=25
Dictionary	25%	F=42, I=58

Negatives	Important	Category
Navigation in message system, especially reading mess	33%	F=50, C=25, O=17
Wrong answer,not enough informtion to understand	83%	F=75, I=25
Introduction to whole system is inadequate, resources e	25%	F=17, I=58, O=17
U and N etc. no explanation	0%	F=33, I=50
Seemed to be testing computer skills-more training	25%	C=17, I=42, O=33
Too high level if never done accounting	17%	C=17, I=67, O=17
Not enough explanation for spreadsheet answers	75%	F=83
Access to dictionary, etc. for spreadsheet answers	25%	F=50, C=17, I=33
Some test questions a bit vague	33%	F=17, I=58, O=17
Spreadsheet #4 has an error for accrued expenses	0%	F=33, I=50
Some errors in tests	42%	F=25, I=50, O=25
A pointer on to next section or indication of what has be	42%	F=42, C=42, I=16

Appendix G: Email comments and questions

	Category	Comment
1	Complaint	Felt that a discussion tutorial would be more beneficial
2	Complaint	One problem I have had is that the dictionary doesn't contain definitions to all of the words used in the tests
3	Complaint	There's a mistake in the excel spreadsheet for episode 4. The account 'Miscellanous accrued expenses' is not in the trial balance in the question but it is there in the answer sheet. So it is kind of difficult to do the spreadsheet with the missing account from the trial balance. And it would be nice to be able to access the dictionary outside the tests
4	Complaint	The main problem I encountered was the lack of communication between the class. It was quite isolated, working on the computer by yourself. You were not really given the chance to interact with other class members, which was a shame. At the end of each tutorial it should be compulsory to send an e-mail to the class discussion site, where-by in the following week everybody can catch-up to see what was said about last weeks tutorial
5	Complaint	Eposide Four, Test 1, question 1, "Doe" should be Does. Regards
6	Complaint	The spreadsheets are very frustrating to use as they are all over the place, and also there is no row for misc expenses availiable.
7	Complaint	Over all the whole set up is good, but it is very impersonal having to ask questions by mail, as it is really hard to have a disscusion when you have to wait some time for a response. The same applies for asking questions. It is hard to carry on when you have to wait for a response to a question if you require the understanding of a concept before you can carry on to a higher level
8	Complaint	When working on a spreadsheet when the lecture ends it is impossible to know where I finished last time when returning the following week. The spreadsheet cannot be reset (that I can see) so it just has to be left. A suggestion would be to be able to blackout the transactions you have already completed
9	Complaint	I thought it was pretty easy and it repeated it self quite often so I rushed through it and probably could have done better if I slowed down
10	Complaint	There are few typing mistakes I think I see in the computer text, here are the places I see(some of them are wrong space placing between the words):

		1. In episode four test one : first question Doe to "do or does" 2. In the dictionary for closing entries: tot he should be "to the"
11	Complaint	I generally don't think that the hints help very much in the test
12	Complaint	Initially a bit weary and not sure whether the presence of the tutor would be more desirable however this way, although left to yourself a lot, it seems not so bad after all. Would appreciate a lolly or stamp on the hand for good work
13	Complaint	I found the tutorials basically easy but getting into the computer system often took a while. Using Excel was good but it was difficult and annoying flipping up and down the page to answer problems. It was a totally different experience!
14	Complaints	I reckon that multi-choice questions are not that suitable, especially at university level. I recommend that some 'fill in the blanks' questions be included, and there is no hint given. If given it will be identical to common multi-choice questions. Also include some questions requiring students to write/type out the appropriate answers. Whether the question is correct or not depends on whether s/he has the keywords in his or her answer
15	Complaints	There were a few spelling mistakes
16	Complaints	I think that there wasn't enough background information given. I have done accounting for the past four years and I believe that there should have been something like a textbook that was on line for us to use in case of problems. There of course was the hint guides in the tests but they were just hints so they were a little vague. Now you maybe thinking what a silly person she didn't even find the file that was just as she is describing a text book on line, but okay, it wasn't obvious enough for us non-computer users, things need to be REALLY obvious. I also think that when the answers are given there should be some kind of explanation with them.
17	Complaints	I thought that maybe some of the hints for questions could have been maybe a bit clearer. Otherwise I thought it was quite a fun way of learning the basics. The spreadsheets were quite hard to move around to find the information
18	Complaints	I think the computer sessions are pretty cool but sometimes it feels quite strange that you are not able to discuss the questions you have encountered as a group. I must admit if you put out both the test and exercises on the screen and said if you get more than 80%+ it is not necessary to do the exercise, for a lazy person like me I tend to skip the exercise and do the test straight away after I read the introductions. Now that's a difference if we have only discussion tutorials. May be you

		could find some way to make us do some practices before entering the tests.
1	Compliment	I find the AFIS111 computer tutorial a very interesting way to learn the rather uninteresting part of this accounting course
2	Compliment	I enjoyed the tutorials and once familiar with the program found the instructions and tests easy to follow. I felt there should have been some instructions in relation to the spreadsheets to know how to add and subtract each transaction. I know there must be a way, I just haven't found it yet
3	Compliment	This was good
4	Compliment	The thing that I like the most about AFIS online is that I can find out what I know and what I don't know
5	Compliment	I have enjoyed the course especially the idea that you are controlling your own business, it is easier to understand the ideas introduced in the lecturers when you see it used in a practical sense
6	Compliment	It's kind of fun doing this tutorial on line and at my own pace. And it's great to have an auto correct for the tests
7	Compliment	I enjoyed being able to see the results instantly and also enjoyed being able to work at my own pace. All in all it was an invigorating and stimulating way to learn
8	Compliment	Personally, I found having these tutorials was most effective. It allowed me to work through at my own pace, sorting through the questions at my own speed and ability. The fast response about whether you were correct in your answers was excellent. This enabled you to monitor your progress as you went, which was extremely helpful. Also, it actually was quite fun to "play around" on the computer at my discretion. Well done
9	Compliment	I think this is a much better way to study, it has an on board help option which can be useful at times
10	Compliment	I'm finding the opportunity to do accounting on the computer much more intersting than working straight from a text book. The automatic marking of the tests is good as you immediately find out where you went wrong. On the whole I'm enjoying AFIS online
11	Compliment	Very good, because you can do the work in your own time without having to cart round real heavy books, that in the end get destroyed in your bag and you aren't able to sell them next year cause they look like shit. but this is very new and exciting!!
12	Compliment	I think that this was a great way to get started into this type of accounting as it gives feedback while still allowing you to learn for yourself. My Tutor has been great when needed to answer questions and people in the class have shared information at times

		rather than just staring at the screen. It will be nice (I hope) to have a real person for a while though.
13	Compliment	The hints seem good although I didn't use them much. They give assistance without telling the answer which is ideal
14	Compliment	It was a good program. There were a few spelling mistakes... but other than that it was fine
15	Compliment	It was a good program. I could do it in my own time and own pace. The answers were available immediately. The questions were of a nature where you could do the test, receive evaluation and then practice again... in case you made some mistakes(which happened often !)
16	Compliment	I especially found the instant marking of the test of much help as I was able to look through the tests and see what I got wrong and was able to locate where I went wrong whether it was an interpretation mistake or simply no knowledge of it. It was heaps of fun and very interesting compared to tute groups of other subjects
17	Compliment	I think that the tutorials have been set out well and they are logically set out
18	Compliment	The biggest thing that I appreciated was the fact that when you submitted a test, you got an immediate response and new how you had done. This meant that straight away you knew what you had to go over while the questions were still fresh in your mind. It was also good working at your own pace, and having the chance to work on it out of tutorial time
19	Compliment	It is good to be able to come in at any time as it is not always possible to attend tutorials at specific times. Well done
20	Compliment	I liked the way that we had hints to help us and the fact that the problems were everyday problems associated with our lifestyles
21	Compliment	Just a quick message to let you know that I enjoyed the www tutorials because, doing them on the computer allowed us to work at our own pace. Thanks
24	Compliment/ complaint	I think the computer sessions are pretty cool but sometimes it feels quite strange that you are not able to discuss the questions you have encountered as a group. The lovely and colourful background along with texts certainly make it more attractive than reading the thick textbooks. I think if we can have a mixture of the computer and discussion tutorials will be cool, say, like one week in Vault and one week in the discussion group. What do you think? I must admit if you put out both the test and exercises on the screen and said if you get more than 80%+ you are not necessary

		to do the exercise, for a lazy person like me I tend to skip the exercise and do the test straight away after I read the introductions. Now that's a difference if we have only discussion tutorials. May be you could find some way to make us do some practices before entering the tests. Also, we tend to just do the computer tutorial staff and don't do the discussion tutorials questions(I mean the one meant to do in the discussion tutorial time)in the computer room, we don't have the time to do it. So may be you can find some solutions to it too. Overall, the experience learning from the computer is cool and pretty interesting. Just that we need to find some way to balance between the two.
1	Guidance	I have already submitted tests for episodes two and three of the tute but there is still an N there beside the episodes folder. I would really appreciate it if you could sort that out. If I have finished all four episodes do I still need to come to the tute?
1	Help	Question one in the 1st episodes answer wouldn't be debit accrual expense and credit cash at bank which is debit liability and credit assets? Because the invoice was sent last month, so would we record it as a accrual expense?
2	Help	Transpositions, Slides, Nominal accounts. I am just a little bit unsure as to the definitions of the words which I have mentioned above. I was wondering if I could have a brief explanation about them
	Overview	Student felt that the on-line tests were of a good introductory level, covering a broad range of material. She had HS accounting

Appendix H: Follow up Interviews with AFIS 111 students: ten months later

Follow up Interviews with AFIS 111 (1998) Students

Student Name ______________________ Date ______________________

BlmLoDif ______________ BlmHiDif ______________ AFIS 111 Grade __________

Willing to meet again?______ Gave Business card?_________

I am doing a few follow up interviews with students who participated in the AFIS 111 experiments I conducted in 1998. In particular I am talking to those who **improved the most or least** from the Pre-test to the Post-test (multi choice) I conducted in class on double entry basics.

What do you think most contributed to your large increase (or lack of increase) during the double entry part of AFIS 111 in 1998? Include events and circumstances external to the course or University as well as your study approach.______________________________

____

____

____

____

(Course related: lectures, tutorials, computer labs (for treatment group). External issues: work, family etc. pressures, being generally slack etc.)

How much **control** do you think you had over your learning in the tutorials?________________

____

____

To what extent do you think this level of **control** contributed to your large increase (or lack of increase) during the double entry part of AFIS 111 in 1998?______________________________

____

How much **feedback** do you think you had in the tutorials?______________________________

____

To what extent do you think this level of **feedback** contributed to your large increase (or lack of increase) during the double entry part of AFIS 111 in 1998?______________________________

____

Appendix I-1: Pre-test

WWW-AFIS 111 Pre-Test - 1998

The following personal details are required for research purposes. Fill in the blank or circle the appropriate response. This information will be kept confidential, with information only being used in a summarised form.

Name:	Assigned Tutorial Day and Time:
Student ID: ______________	Ethnicity: Asian European Maori Other (specify) ________________
Sex: M F	Age Range: 17-19 20-25 26-35 36 and over

	Level of Prior Accounting Experience: 5th Form Grade: ______________________ N/A ☐ 6th Form Certificate Grade Level: ________ N/A ☐ 7th Form Bursary Percentage: ___________ N/A ☐
	Level of Prior Computing Experience (circle): None Very Limited Moderate Very Experienced

The following multiple choice questions relate to a sole proprietor retail store selling clothing and using accrual accounting. They prepare monthly reports and use a perpetual inventory system. Answer all the questions on the following pages by filling in completely your chosen answer box on the answer sheet below:

1.	a	b	c	d	13.	a	b	c	d
2.	a	b	c	d	14.	a	b	c	d
3.	a	b	c	d	15.	a	b	c	d
4.	a	b	c	d	16.	a	b	c	d
5.	a	b	c	d	17.	a	b	c	d
6.	a	b	c	d	18.	a	b	c	d
7.	a	b	c	d	19.	a	b	c	d
8.	a	b	c	d	20.	a	b	c	d
9.	a	b	c	d	21.	a	b	c	d
10.	a	b	c	d	22.	a	b	c	d
11.	a	b	c	d	23.	a	b	c	d
12.	a	b	c	d	24.	a	b	c	d

	Note not included with original test: The Bloom's High and Low categorisation for the following test questions is noted at the end of each question with the following legend: 1=Bloom's Low: K=Knowledge, C=Comprehension, Ap=Application 2=Bloom's High: An=Analysis, S=Synthesis, E=Evaluation
1.	You have just purchased some office furniture for cash, which category would you debit, which category would you credit? a. Debit an asset, credit a liability b. Debit an expense, credit an asset c. Debit owner's equity, credit an asset d. Debit an asset, credit an asset 1.co
2.	If the owner has invested $2,000 in the business and the total assets equals $5,000, what is the amount of the total liabilities? a. $7,000 b. $2,000 c. $3,000 d. $5,000 1.ap
3.	Inventory is purchased on credit from Jones & Co. for $2500. Your account with Jones & Co. had a balance of $3000 owing prior to this purchase. You credit the account for the new purchase. Identify the account and the new balance below: a. Inventory with a balance of $5500 b. Accounts payable with a balance of $500 c. Inventory with a balance of $500 d. Accounts payable with a balance of $5500 2.an
4.	The owner makes an investment of $10,000 in cash to the business, this would be recorded by: a. Debiting cash in bank and crediting the owner's drawing account b. Debiting Inventory and crediting accounts payable c. Debiting cash in bank and crediting the owner's equity account d. Debiting loans payable and crediting the owner's drawing account 2.an
5.	Which of the following is an accurate representation of the accounting equation? a. Assets + Liabilities = Owner's Equity b. Assets = Liabilities + Owner's Equity c. Revenues - Expenses = Net Profit d. Assets - Expenses = Owner's Equity 1.kn
6.	Business gross profit is equal to: a. Total revenues - total expenses b. Assets - liabilities c. Total sales - total cost of sales d. Owner's equity - owner's drawings 1.co
7.	You buy a new computer, paying part in cash and part on hire purchase. The transaction would be recorded as: a. A debit to computer, a credit to cash and a credit to hire purchase liability b. A debit to computer, a credit to cash c. A debit to cash, a credit to computer and a credit to hire purchase liability d. A debit to computer and credit to accounts payable 2.an

8.	Accounts receivable (Debtors) is an example of what type of account: a. Liability b. Expense c. Asset d. Revenue 1.kn
9.	You decide to return some inventory to a supplier. The goods were purchased on credit, the return would be recorded by a: a. Debit to accounts payable and a credit to sales returns b. Debit to accounts receivable and a credit to sales returns c. Debit to account payable and a credit to equipment d. Debit to accounts payable and a credit to inventory 2.an
10.	A customer makes a deposit on goods you will deliver in a month's time. This will be recorded by a: a. Debit cash in bank and a credit to cost of sales b. Debit to cash in bank and a credit to revenue received in advance c. Debit to cash in bank and a credit to inventory d. Debit to accounts receivable and a credit to sales 2.an
11.	An example of a current asset is: a. Accounts payable b. Inventory c. Telephone expense d. Office furniture 1.kn
12.	You have hired a new salesperson who is really good. You estimate this will increase your sales by $5,000 per month. How should you record this estimate? a. Debit to accounts receivable and credit to sales b. Debit accounts receivable and credit to estimated sales c. Debit wages expense and credit cash in bank d. You should not record estimates 2.sy
13.	The primary accounts on the Statement of Financial Position (Balance Sheet) are: a. Assets, liabilities and owner's equity accounts b. Revenues and expenses accounts c. Cash in-flows and out-flows d. Assets, expenses, drawings, liabilities, income and proprietorship accounts 1.kn
14.	If you pay rent for 6 months in advance, how should this be recorded? a. Debit cash in bank and credit rent liability b. Debit rent expense and credit cash in bank c. Debit rent paid in advance and credit cash in bank d. Debit rent expense and credit deferred rental 2.an
15.	You purchase business office supplies using your personal cheque book, because you don't have the business cheque book with you. Record this by a: a. Debit to office supplies and a credit to cash in bank b. No entry required c. Debit to owner's drawing and a credit to cash in bank d. Debit to office supplies and a credit to owner's equity/drawing account 2.an

16.	The trial balance is: a. A listing of all accounts with their balances b. A draft Statement of Financial Position to see if it balances c. A document to test for omitted and mis-classified entries d. A procedure used in a court of law to maintain equity 1.kn
17.	You have just made a sale to a customer. They have taken the product, but they can't pay you for 30 days. This would be recorded as: a. No transaction should be recorded until they pay you. b. Debit accounts receivable and credit sales c. Debit inventory and credit sales d. Debit accounts receivable, debit cost of sales; and credit sales, credit inventory. 2.an
18.	In reviewing your statement of Financial Performance you see a profit of $2500 this month. In spite of this you are still having difficulty paying your bills on time. The most likely reason for this is: a. Business expenses are too high b. You have reduced your inventory too much c. Business revenues are too low d. You are not collecting your Accounts Receivable fast enough 2.ev
19.	How would you correct this entry? You returned some product to a supplier which had been purchased on credit. You recorded it, in error, as a debit to cash in bank and a credit to inventory. This should be corrected by a: a. Debit to inventory and a credit to cash in bank b. Debit to accounts payable and a credit to cash in bank c. No entry required as it is a self correcting entry d. Debit to inventory, a debit to accounts payable; a credit to cash in bank, a credit to purchase returns 2.an
20.	End of period closing entries include closing: a. All assets and liabilities into owner's equity b. All revenues and expenses into owner's equity c. All assets, liabilities, revenues and expenses into owner's equity d. Revenues and expenses into the current asset category 1.co
21.	What would be the reversing entry needed for an accrued purchase of inventory made on credit? a. Debit inventory, credit accounts payable b. Debit accounts payable, credit inventory c. Debit accounts receivable, credit sales d. Debit accounts receivable, credit inventory 2.an
22.	On which financial statement do you find the detailed computation of net profit? a. Statement of financial position b. Statement of financial performance c. Cash flow statement d. Statement of owner's equity 1.kn

23.	On which financial statement do you find current assets? a. Statement of financial position b. Statement of financial performance c. Cash flow statement d. Statement of owner's equity 1.kn
24.	What is the effect on total assets of paying cash for a new truck? a. Increase in total assets b. Decrease in total assets c. No change in total assets d. Increase in total assets and total liabilities 1.ap

	Attitude Survey: For each item below circle the numbered response that best describes your attitude now:	1=Strongly disagree, 6=Strongly agree
1.	I find accounting very interesting	**1 2 3 4 5 6**
2.	I enjoy using computers to learn with	**1 2 3 4 5 6**
3.	I enjoy learning about accounting	**1 2 3 4 5 6**
4.	Learning accounting is important for my career	**1 2 3 4 5 6**
5.	I am confident using computers	**1 2 3 4 5 6**
6.	Learning to use computers is important for my career	**1 2 3 4 5 6**
7.	I am confident in my accounting knowledge	**1 2 3 4 5 6**
8.	I think computers are interesting	**1 2 3 4 5 6**

Appendix I-2: Descriptive statistics for individual items of Attitude survey (from Appendix I-1)

Descriptive statistics for the eight items on the survey can be seen in Figure I-2. Regarding attitude towards accounting and computing it can be seen that the control group's attitude deteriorated somewhat going down by 1 point, while the treatment group's attitude became somewhat more positive toward the accounting content rising by 4 points. However both groups noted a similar fall in the group attitudes toward computers, with the control group falling by 11 points and the treatment group falling by 12 points. The actual attitude survey can be viewed at the end of Appendix I-1.

Description (variable name in parenthesis)	**Control Group Pre-test**	**Treatment Group Pre-test**	**Control Group Post-test**	**Treatment Group Post-test**
I find accounting very interesting (Atd1)	3.91	3.92	3.72	3.99
I enjoy learning about accounting (Atd3)	4.11	4.06	3.94	4.16
Learning accounting is important for my career (Atd4)	4.68	5.02	4.79	4.76
I am confident in my accounting knowledge (Atd7)	3.16	3.31	3.39	3.55
Mean of four questions	3.97	4.08	3.96	4.12
I enjoy using computers to learn with (Atd2)	4.54	4.57	4.25	4.56
I am confident using computers (Atd5)	3.68	4.15	3.76	4.12
Learning to use computers is important for my career (Atd6)	5.35	5.41	5.23	5.07
I think computers are interesting (atd8)	4.68	4.79	4.55	4.70
Mean of four questions	4.56	4.73	4.45	4.61

Figure I-2: Comparison of means on attitude survey portion of pre-test/post-test
(Student responses on the attitude questions used a 6 point likert scale with 1=strongly disagree and 6=strongly agree)

Appendix I-3: Comparison of MRA to SRA results for impact of attitude on student learning

In addition to the simple regression analysis (SRA) carried out above, a multiple regression analysis (MRA) was carried out on Equation 4b (impact of attitude on student learning) to consider the impact of both attitude variables (accounting and computing), in order to test for spurious results of using only one attitude variable at a time. The results of the MRA are seen in Figure I3-1. Caution in the use of these results is urged in that the n size of 28 is small. The primary purpose for its use in this case is to validate the results of the simple regression analysis (SRA).

Accounting Attitude	**DV: PosScor;** R^2= 0.678, P-Val= 0.000				**DV: PosBlmLo;** R^2= 0.680, P-Val= 0.000				**DV: PosBlmHi;** R^2= 0.505, P-Val= 0.002			
Independent Variables	Coef	T	P-Val	Signif	Coef	t	P-Val	Signif	Coef	T	P-Val	Signif
β_{S1} = PosAtdA	0.029	4.259	0.000	1%	0.030	3.870	0.001	1%	0.032	3.315	0.003	1%
β_{S2} = PosAtdC	-0.012	-1.931	0.066	10%	-0.006	-0.899	0.378	N.S.	-0.016	-1.891	0.071	10%
β_T=Category	0.032	1.859	0.076		0.021	1.082	0.291		0.033	1.416	0.170	
β_X =Pretest	0.559	4.404	0.000		0.411	4.003	0.001		0.549	3.283	0.003	

Figure I3-1: Multiple Regression Analysis for Equation/Hypothesis 4b, impact of attitude on student learning, $Y=\alpha + \beta_{S1}S_1 + \beta_{S2}S_2 + \beta_T T + \beta_X X + e_Y$

Figure I3-2 compares the MRA and SRA results, and demonstrates that the MRA confirms the results of the SRA in general with the MRA results producing the same 1% significance levels for the accounting attitude variable (PosAtdA). The MRA produces a somewhat stronger result for the computer attitude variable with a significant negative result at the 10% level, while the SRA produced a results that was non-significant being somewhat below the 10% level. The negative coefficient on the computing attitude variable may indicate that a rise in attitude towards accounting resulting in better test performance (in conjunction with being in the treatment group) may be slightly at the expense of attitude towards computing.

	Multiple Regression Results Equation/Hypothesis 4b: S → Y relation			**Simple Regression Results Equation/Hypothesis 4b: S → Y relation**		
	PosScor Signif.	**PosBlmLo Signif.**	**PosBlmHi Signif.**	**PosScor Signif.**	**PosBlmLo Signif.**	**PosBlmHi Signif.**
PosAtdA	1%	1%	1%	1%	1%	1%
PosAtdC	10%	N.S.	10%	N.S.	N.S.	N.S.

Figure I3-2: Comparison of MRA results to SRA results

Appendix J: Note to Tutors on administration of AFIS On-Line Learning Survey

The last 15 minutes of this week's tutorial is being devoted to conducting a Learning Survey. Please allow sufficient time to handout the attached survey, with students having at least 15 minutes to complete the survey.

This survey is part of the research work being conducted by John Vargo in conjunction with Internet based learning systems, and has George Thompson's agreement to be administered in this week's tutorial. The large majority of students in your tutorial have agreed to participate in this research. As a result you should hand a copy of the survey to each student in your tutorial. If any students say they are not participating in the research, then simply retrieve the survey from them without it being completed.

When handing out the survey you should give students the following instructions:

"Please fill in the survey I am handing out, it is in conjunction with the research work that John Vargo is doing. Be sure to complete the Name, Student ID and tutorial details at the top before you start. You will have 15 minutes to complete this survey. Thank you for your cooperation in this."

Once students have completed the survey form, collect them and return them to Tineke Patterson, HOD's secretary in room 604, or to John Vargo directly in Room 603.

After collecting survey forms from students, please announce:

"If you have not finished all four episodes of the AFIS On-line system, it will continue to be available over the next few weeks."

Thank you very much for your assistance with this.

John Vargo

Appendix K: Summary of learning survey outcomes

The following table contains the same material as presented in Figures 6-3, 4 and 5 of Chapter 5, however this table has been sorted into question number order as presented in the treatment group learning survey found in Appendix D.

Mean score or other statistic

Ctrl Grp Q#	Trmt Grp Q#	Var 3	Survey Question/ Description	Ctrl Group	Treatmt Group	Trtmt Grp No Useage
	1	c	Ability to choose my "Episode" type	-	3.62	8
	6	**c**	**Flexibility of timing and accessibility to material (24 hour access to WWW materials)**	-	**5.52**	**6**
	9	c	Control provided by WWW browser and hypertext environment	-	4.27	0
7	**13**	**c**	**Control over my learning environment**	**3.93**	**4.62**	**0**
11	**18**	**c**	**Ability to control the pace of my learning (I could take as much or little time as I needed)**	**4.05**	**5.26**	**0**
	2	**f**	**Getting rapid automated feedback on the tests**	-	**5.34**	**1**
	4	f	The ability to have two-way (email) communication with tutors	-	4.26	40
	8	f	Availability of on-line discussion groups	-	3.94	40
2	11	f	Overall level of feedback	3.85	4.36	**0**
10	**14**	**f**	**Relating to other students in tutorial**	**4.04**	**3.40**	**16**
	16	f	The ability to have two-way (email) communication with students	-	4.10	44
4		f	Solutions to tutorial questions	4.30		
6		f	Tutor's answers in tutorial	4.41		
9		f	Solutions to preparation problems	4.55		
5	**3**	**i**	**(Tutorial materials and discussion) or (The AFIS On-line system) provided a cohesive, consistent, in-context, learning system**	**4.07**	**4.47**	**0**
	5	i	The use of Episode scenarios to add context to learning	-	4.51	0
	7	i	Availability of the Frequently Asked Questions (FAQs) Help	-	4.14	24
	10	**i**	**Use of excel practice spreadsheets**	-	**4.88**	**3**
	12	**i**	**Availability of the dictionary on-line**	-	**4.67**	**11**
3	15	i	Use of clarifying examples	4.15	4.14	7
	17	i	Availability of text-book references on-line	-	4.04	29
	19	**i**	**Use of the "hints" button on the tests**	-	**4.61**	**4**
1		i	In tutorial discussion of questions and problems	4.21		
8		i	Doing the preparation problems	4.74		
12	**20**		**Hours spent on tutorial material**	**6.27**	**4.01**	**0**
13	21		Tutorials attended (out of three)	2.72	2.85	0
	22		**Did you access the WWW tutorial material outside of tutorial hours? (% who said yes)**	-	**66.2%**	
	23		**Did you access the WWW tutorial material from off campus? (% who said yes)**	-	**23.3%**	

Figure 5-3: Comparison of means from initial research outcomes on survey

(Student responses on item reported above used a 6 point likert scale with 1=strongly disagree and 6=strongly agree) (see Appendix D & D-1 for original survey instruments)

Appendix L: Comments from survey open question

The following table lists the comments made by treatment group students on the one open question included with the learning survey (see Appendix D). The table includes an identifying number for the student who made the comment, with some students making multiple comments. The table is sorted into order by Positive comments (P) and Negative comments (N) in the same category number order as presented in the later part of Chapter 5 entitled "Summary of comments from learning survey open question".

Student	Category	Pos/Neg	Comment
20	1	P	Interesting way of learning but it takes a very long time to do all the episodes
21	1	P	Very good learning tool
22	1	P	Better way to learn and revise and remember work
23	1	P	Overall, I found learning from the computer good except when I didn't have a tutor- I couldn't ask questions
24	1	P	I liked it, easy to use in conjunction with text...spreadsheets useful (sometimes inconveniently set out though).
25	1	P	I like the concept of learning by use of computers but have to wonder if we aren't tested the same way for certain exams, how worthwhile is it?
26	1	P	Quite an interesting way of learning, fun, so you actually enjoy working on it
27	1	P	Interesting
28	1	P	Fun, helped a lot. I wish other classes had this system
29	1	P	Good fun way of learning
30	1	P	It is quite good but apart from that they are a lot better than sitting in front of a lecturer for an hour
31	1	P	An interesting way of learning
34	1	P	It was useful, especially the practical examples
35	1	P	Good idea, should be expanded (if possible)
36	1	P	Very useful to do. Helped with the overall learning.
38	1	P	Excellent form of learning
39	1	P	They were better than I had originally thought, great to have examples!
40	1	P	Really good, more variety of questions in the test would be better

43	1	P	They were enjoyable
47	1	P	Enjoyable good learning experience
57	1	P	Excellent way to learn. I strongly agree to this type of learning
60	1	P	A really good idea and easier learning from the lecture tutorials
61	1	P	I thought they were great- for me, a valuable learning tool. I found the spreadsheets particularly useful. Maybe more of these??? Excellent!
70	1	P	Otherwise, I feel this system is very helpful
41	1	P	Would be great if every relevant example from the text was available on-line - saves paying $100 - (great help)
44	2	P	Cool!!!
45	2	P	Good
46	2	P	Cool
48	2	P	Quite good
49	2	P	Pretty good
50	2	P	Pretty good
51	2	P	It's all good
52	2	P	Very good
53	2	P	Very good
54	2	P	I liked them
55	2	P	No comments. I strongly agree with all the resources available!
56	2	P	It was good
58	2	P	Everything great
59	2	P	V.good
62	2	P	Good stuff! I enjoy that.
63	2	P	It was pretty good actually
64	2	P	It was good
65	2	P	It was good
2	3	P	Good tutor for student learning because time is more flexible
3	3	P	A few things need to be ironed out, but a great option for those people who are restricted by the number of hours available to spend at university

4	3	P	Good that work can be done in own time, especially off campus
5	3	P	I found the computers a great way of learning especially to be able to work through at my own pace
6	3	P	flexibility of timing and accessibility to material
6	3	P	the ability to control the pace of my pace of learning
7	3	P	Good if you want to work on them whenever you want,
8	3	P	V. good to aide in learning, working at own pace when ever we want to access it
10	3	P	Excellent, good to work at own pace and able to ask questions at same time
12	3	P	But good to work at own pace
14	3	P	Awesome system as you work at your own speed and have assitance when help is required
16	3	P	Love the fact that one can learn at one's own pace
17	3	P	This was a very good course being able to do the work from home
18	3	P	It was great being able to do the tutorials from home
24	3	P	Being able to access it outside of tut time was the best aspect
42	3	P	Good for people with a little accounting knowledge
67	3	P	I did enjoy working at my own pace
6	4	P	I like the idea of inter-active tutorials, ie the automated feedback on tests.
7	4	P	Automatic feed back was REALLY helpful
9	4	P	It is a great way of learning as you don't have to wait for marking- it is done immediately and you can see where you went wrong
11	4	P	I found the instant marking of tests helpful as through the answers I could logically see why I got them wrong
13	4	P	It's very much helpful with the episodes to know how much I understand with AFIS 111.
15	4	P	Very good idea, good learning environment, I especially liked the automated feedback,. Good work! :)
19	5	P	Very good way of doing accounting. I thought the tutor could have explained what we were supposed to be doing a lot more, because most people were very unsure of what was expected of us. Much better way of learning accounting for those who have had a little prior experience.

32	5	P	Very good environment for picking up basics of accounting
33	5	P	Very good in advance on learning accounting environment
37	5	P	I think it is a very good program for student who have never done accounting before
39	5	P	I am totally new to accounting & this helped my learning more than lectures
1	6	P	Helpful, provided a good social environment
66	7	P	It is very handy if you make mistakes, numbers can be deleted easily. It is also helpful for improving your computer skills
15	8	P	Liked the on-line dictionary
30	1	N	There is the occasional spelling mistake etc
75	1	N	Tests are almost exactly the same in the episodes
82	1	N	Repetitive test questions
83	1	N	Perhaps having some tests based on the spreadsheets rather than all on questions
85	1	N	Quiz questions seemed to be repetitive pattern, explanations with answers need to be more informative
86	1	N	So many questions haven't got hints and hints sometimes are not clear enough to understand the question
89	1	N	Dictionary could be more comprehensive
91	1	N	The hint button doesn't work sometimes
92	1	N	Some questions need more explanation
93	1	N	The questions of the spreadsheet could have been made a little clearer
98	1	N	Got too repetitive
67	2	N	Need more interaction with students on computers. Should be made to e-mail everybody in you tutorial, introducing yourself
68	2	N	I thought it was difficult as you didn't really get the student to teacher or tutor help.
69	2	N	No communication "human touch".
70	2	N	The only thing is I feel you learn better from discussion with the tutor and other students.
71	2	N	Not a lot of direction, you could hardly call it a tutorial, when nobody "tutors" you

72	2	N	Would prefer "man to man" contact - lectures basically pretty sterile as is tutorials are only "human contact" (not quite) Do not like to miss tutorial but some reason these are not held every week. Making printouts (powerpoint) before the lectures would help
12	2	N	Very impersonal
13	2	N	Though I think we still need tutor for a better explanation
26	2	N	A little antisocial though but effective
58	3	N	It's a problem flicking back and forth to numbers and spreadsheets
73	3	N	I don't think it is a successful substitute for a classroom situation, even if it was set up with people emailing comments. I personally find it quite hard to just learn from reading off a screen. What sort of preparation was required for tuts?
84	3	N	None except I found the spreadsheets hard to follow
87	3	N	For the spreadsheet tutorials, it would be beneficial if step by step working is available instead of straight off answers. It could be pretty hard to understand
88	3	N	There is a small problem with the spreadsheet on episode 4. With adjustment 2 the revenue received in advance was debited which is correct but no account was credited. However in the statement of financial performance sales has increased by $1000
90	3	N	The spreadsheets were too difficult to operate, especially after you made a mistake and had to backtrack
94	3	N	The excel spreadsheets could have been done in steps so as to easily see where mistakes occurred
101	3	N	I found it hard to follow. It seemed quite confusing in that I didn't know where I was going
69	3	N	I felt isolated and confused to begin with
6	4	N	But I HATE the Internet
39	4	N	I still find books easier to flick through & navigate., although this system wasn't usually a hindrance at all.
77	4	N	Alright, but I think I'd learn more out of doing the textbook problems
78	4	N	I found computer access slow/long to load up programmes, prefer class tutorials
79	4	N	Good, but I think I would prefer normal class work
42	5	N	Not so good for beginners in accounting

54	5	N	Better to do this style of learning if you've already done Accing before ie you know the Accing Cycle. Because I think its important to understand what you're doing & the computer does kind of skip a few parts of that
68	5	N	As this is my first time doing accounting it becomes very difficult to get many questions correct
74	5	N	Having not done accounting I would rather have had a tutor working through the problems. I think this is a better way to learn
76	5	N	My inexperience with accounting made it difficult for me to learn
76	6	N	Weren't that good for me as the combination of my inexperience with computers
69	6	N	I spend half my time trying to get established and familiar with the computer
80	6	N	For people with limited exp in computers quite difficult!
81	6	N	If I was offered the opportunity to do another computer tutorial session I would be a little apprehensive as I found the computers a little hard to find my way around
95	7	N	Would if we had more time to look at dictionary and e-mails instead I felt if I just had to do the episodes
96	7	N	May be doing them for one hour gets a bit long in the tooth. It could be better for half an hour and then discuss as class?
97	7	N	Find it hard to stare at screen for an hour
100	7	N	The backgroud of the test can be improved, cause sometimes it make my eye turn dry when I use it for long time
99	8	N	Problem occurs when the server is busy

Appendix N: Detail regression tables showing impact of process variables on engagement variables

DV: S_E=Various				IV: β_{SP}= Various				IV: β_T'=Category		
	R^2	F-Ratio	P-Val		Coef.	t	P-Val	Coef	t	P-Val
4a. PosAtdA	0.518	8.584	0.000	Control	0.202	0.510	0.615	0.408	0.876	0.390
PosAtdA	0.525	8.828	0.000	Feedback	-0.329	-0.785	0.440	0.726	1.899	0.070
PosAtdA	0.524	8.818	0.000	Context	-0.307	-0.776	0.445	0.561	1.700	0.102
4b. PosAtdA	0.553	5.452	0.002	Control	0.551	1.154	0.261	0.298	0.541	0.594
				Feedback	-0.409	-0.630	0.535			
				Context	-0.297	-0.496	0.625			
4a. PosAtdC	0.427	5.955	0.003	Control	0.512	1.058	0.301	0.047	0.081	0.936
PosAtdC	0.406	5.462	0.005	Feedback	0.250	0.482	0.634	0.350	0.709	0.485
PosAtdC	0.408	5.524	0.005	Context	0.288	0.585	0.564	0.496	1.160	0.258
4b. PosAtdC	0.428	3.288	0.023	Control	0.522	0.858	0.400	0.128	0.167	0.869
				Feedback	-0.159	-0.178	0.860			
				Context	0.138	0.166	0.870			
4a. Time	0.373	7.420	0.003	Control	0.712	1.202	0.241	-2.405	-3.461	0.002
	0.338	6.378	0.006	Feedback	-0.158	-0.250	0.805	-1.750	-2.981	0.006
	0.362	7.087	0.004	Context	-0.590	-1.002	0.326	-1.853	-3.684	0.001
4b. Time	0.460	4.902	0.005	Control	1.307	1.896	0.071	-3.049	-3.840	0.001
				Feedback	0.190	0.203	0.841			
				Context	-1.367	-1.588	0.126			

Figure N-1 (7-5): Equation 4 (using composite variables for control, feedback and in-context):
$S_E = \alpha + \beta_{SP} S_P + \beta_{SE}' S_E' + \beta_T T + e_{SE}$ (β_{SP}' P-Values all < 0.003, so not included in table)